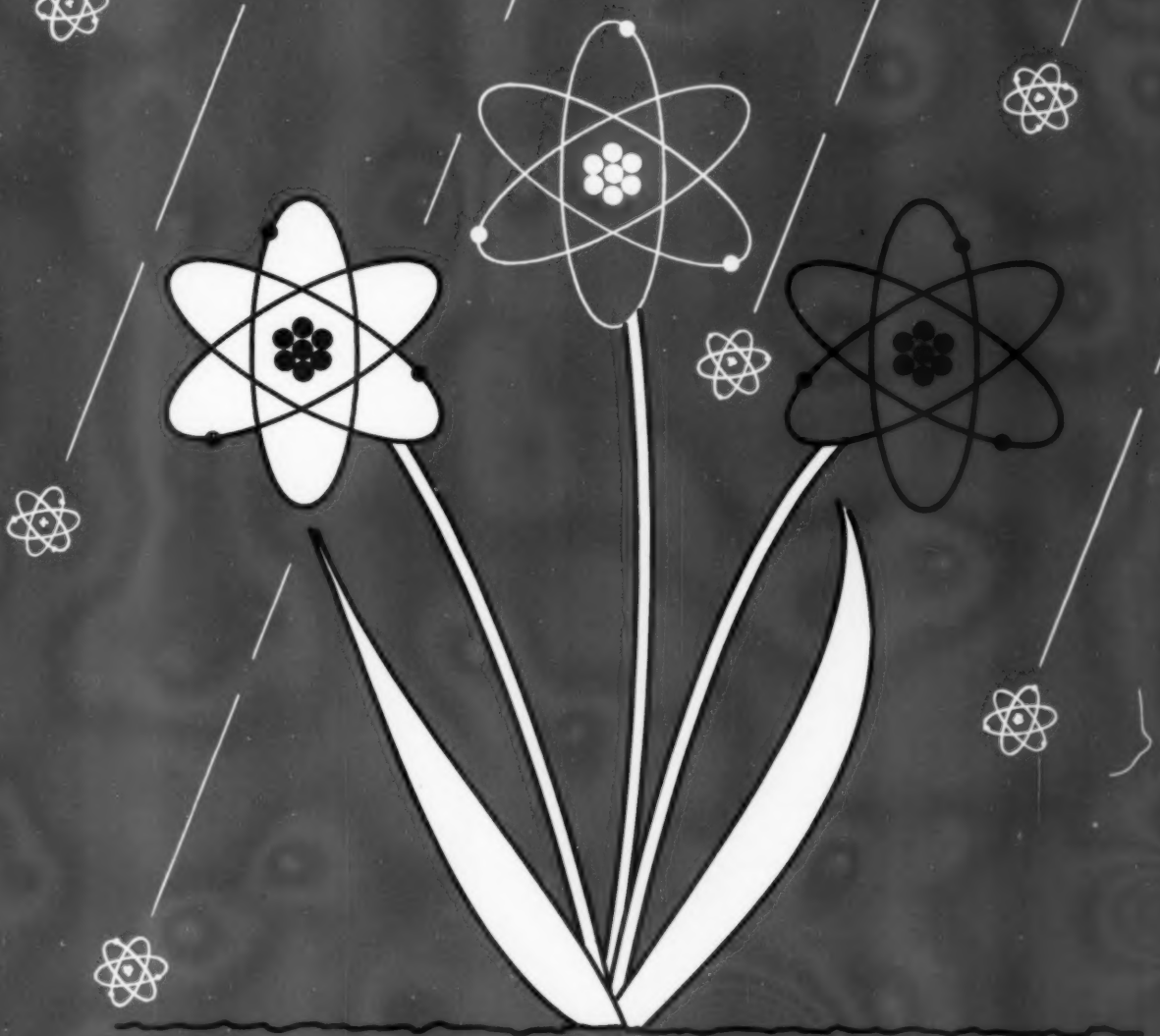
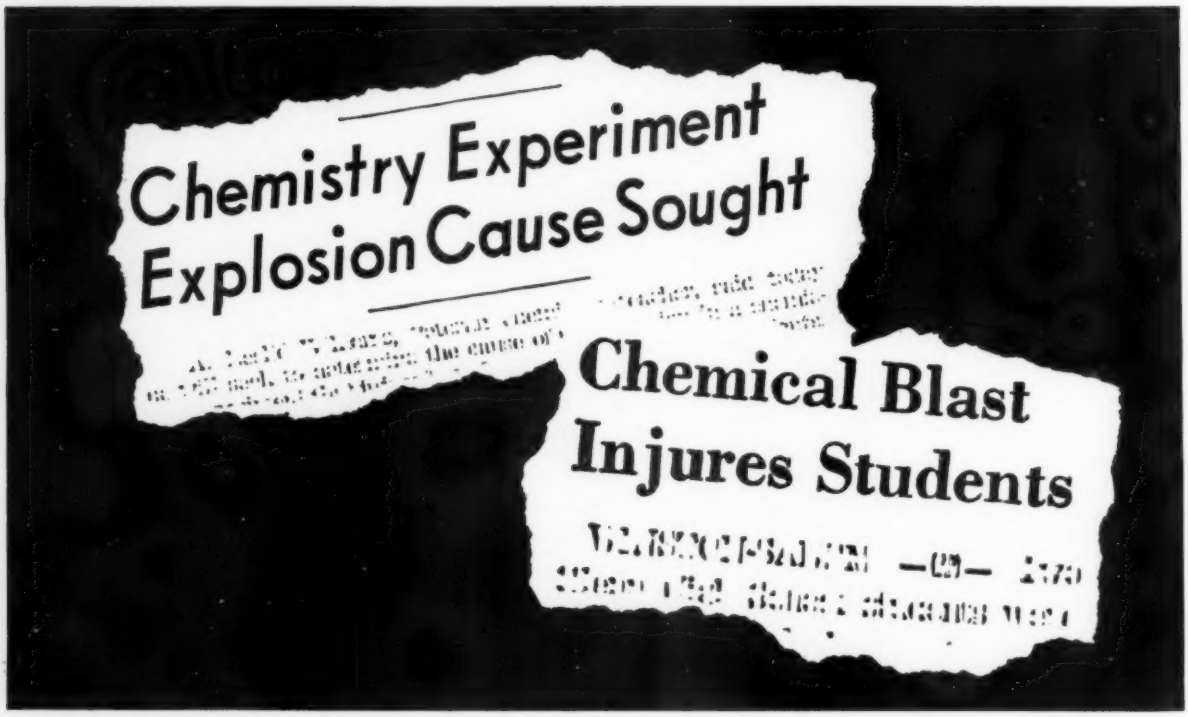
Vol. XXV, No. 2
MARCH 1958

THE SCIENCE TEACHER



JOURNAL OF THE NATIONAL SCIENCE TEACHERS ASSOCIATION

Could This Happen in Your Lab?



Mishaps can occur—even in the best regulated chemistry lab. But adequate precautions can practically eliminate the risk of serious injury.

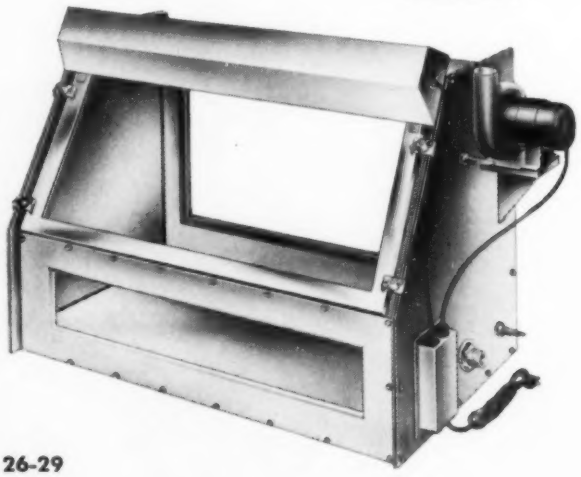
This is the reason more and more high schools are equipping their science rooms with Kewaunee FLEXIHOODS.

The Kewaunee FLEXIHOOD is portable, easily moved within a lab and from room to room. It provides safe, sure fume removal, plus protection against other hazards of experiments.

The FLEXIHOOD makes an excellent lecture-demonstration unit—glass paneled front and back provides students with a clear view of the experiment being conducted.

36½" wide (43" with attached blower), 25" high, 20" deep, the compact FLEXIHOOD requires no expensive installation for blower and duct system, nor does it need fixed mechanical services.

Write for FREE brochure giving complete details and specifications on the efficient, portable FLEXIHOOD.



Kewaunee

KEWAUNEE MANUFACTURING COMPANY

5122 S. Center Street, Adrian, Michigan

REPRESENTATIVES IN PRINCIPAL CITIES

Visit our Exhibit, NSTA Convention, Denver, Colo., Mar. 26-29

Popping up every day!

Science keeps popping up in the news these days. More than ever, interesting and accurate science instruction at the high school level is a vital need. That's why we're especially proud to publish the up-to-date, absorbing texts that constitute the

D/N SCIENCE PROGRAM

SCIENCE IN EVERYDAY LIFE, 1958 edition

Obourn, Heiss, Montgomery

An exciting, timely text for ninth-grade general science students. It thoroughly explores the latest uses and potential development of earth satellites, atomic energy, radar, plastics, television, automatic computers, etc.

BIOLOGY—A BASIC SCIENCE, 1958 edition

Heiss, Lape

This entirely new biology for high schools teaches the basic facts, principles, and concepts of biology as a dynamic and vital force in the students' daily lives.

PHYSICAL SCIENCES—A BASIC COURSE, 1958 edition

Hogg, Cross, Vordenberg

Meaningfully illustrated with hundreds of clear diagrams and photographs, this new text (which will be published late this Spring) presents a broad survey course in chemistry, physics, earth science, meteorology, and astronomy.

CHEMISTRY—A BASIC SCIENCE, 1957 edition

Hogg, Alley, Bickel

Revised throughout in order to reflect the latest advances in chemistry, this Fourth Edition features a greatly expanded unit on atomic energy and new presentations of the atomic theory and chemical arithmetic.

PHYSICS—A BASIC SCIENCE, 3rd edition

Burns, Verwiebe, Hazel, Van Hooft

This is an exciting textbook in which students are introduced to basic principles through ordinary activities; there is constant emphasis upon the relation of physics to everyday life.

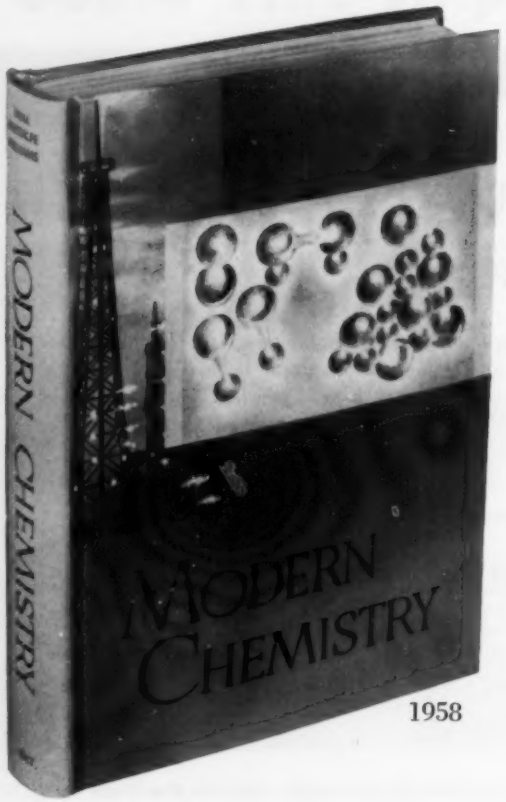
EARTH SCIENCE—THE WORLD WE LIVE IN

Namowitz, Stone

Each of the text's five units deals with a major area of the high school course—geomorphology, astronomy, meteorology, oceanography, and climatology.

VAN NOSTRAND

120 Alexander Street
Princeton, New Jersey



An outstanding example of Holt's time-proven, sound philosophy in presenting the principles and applications of science clearly, purposefully, and without compromising those basic values so essential to our science education today.

In preparation—

de Bruyne:

SEMIMICRO LABORATORY MANUAL

Castka:

CHEMISTRY PROBLEMS

(Additional correlating materials listed below *)

THE HOLT SCIENCE PROGRAM

SCIENCE 1 and 2 *(Grades 7, 8)*
SCIENCE 3 *(Grade 9)*
MODERN BIOLOGY
LIVING THINGS
MODERN HEALTH
MODERN CHEMISTRY
MODERN PHYSICS
MODERN PHYSICAL SCIENCE

* A complete program of correlating materials accompanies each book of the Holt Science Program: Teacher's Manual and Answer Book (for the text), Student Workbook, Tests, Key to Tests. Separate Laboratory Experiments in Physics and in Chemistry. Teacher's Edition or Answers available for all workbooks and laboratory manuals.

HENRY HOLT AND COMPANY

383 Madison Avenue, New York 17
410 N. Michigan Avenue, Chicago 11 536 Mission St., San Francisco 5

THE SCIENCE TEACHER

Staff

ROBERT H. CARLETON — Editor
JERRY ASKWITH — Managing Editor
MARY BATISTE MURCHISON — Advertising Manager
E. LOUISE LYONS — Subscriptions

Advisory Board

ABRAHAM RASKIN (1959), CHAIRMAN
RICHARD R. ARMACOST (1958)
ESTHER BOSSUNG (1960)
PAUL F. BRANDWEIN (1958)
JOHN H. MAREAN (1959)
RICHARD SALINGER (1960)

Science Consultants

William Jones Bowen, National Institutes of Health, BIOLOGY
James W. Cole, Jr., University of Virginia, CHEMISTRY
John S. Toll, University of Maryland, PHYSICS

Articles published in THE SCIENCE TEACHER are the expressions of the writers. They are not a statement of policy of the Association or the Magazine Advisory Board.

The National Science Teachers Association is a department of the National Education Association and an affiliate of the American Association for the Advancement of Science. Established in 1895 as the NEA Department of Science Instruction and later expanded as the American Council of Science Teachers, it merged with the American Science Teachers Association and reorganized in 1944 to form the present Association.

Vol. XXV, No. 2 **March 1958**

To the Edge of Space: IGY Upper Atmosphere Studies
Alan H. Shapley 69

A Pro for the Planned Program
Grace C. Maddux 72

From Research to Classroom Laboratory: Analysis of Radioactivity in Vegetation
T. Handley Diehl and L. R. Setter 77

Rainout Studies and Techniques
T. Handley Diehl and L. R. Setter 80

Guideposts in Science Education
Sam S. Blanc 82

Summer Research Assistantships for Science Teachers 86

NSTA Convention Highlights 88

Classroom Ideas

Paraffin Models
Marie G. Barnes 92

Some Materials That Help Get the Idea Across
Leona K. Adler 92

Features

This Month's Cover 62
Editor's Column 64
Readers' Column 66
NSTA Activities 102
FSA Activities 106
Book Briefs 108
Bulletin Board 108
NSTA Calendar 110
Audio-Visual Reviews 111
Index of Advertisers 112

New Additions

Elementary and High School

SCIENCE (Workbooks)

Grades 1–6

by SMITH

. . . a new, six-book activity program providing a complete elementary science presentation. SCIENCE (Workbooks) give personal student participation in careful observation, classification, experiments, and discovery of relationships—the basic ideas of scientific thinking. Content, color, and adaptability make these books a valuable addition to any elementary curriculum. Separate Teacher's Editions will be available upon request.

BIOLOGY FOR YOU

Fourth Edition

by VANCE and MILLER

. . . featuring a 15-page overview of biology in our world today—in color and black and white. BIOLOGY FOR YOU—4th Edition provides secondary school students with the background to understand the life sciences by studying insects, flowers, plants, birds, and mammals. It arouses appreciation not only of the contribution of biological sciences, but of such phenomena as autumn foliage and sunsets, medical research, and radioactivity.

J. B. LIPPINCOTT COMPANY

Chicago Philadelphia Atlanta

THE SCIENCE TEACHER

The Journal of the National Science Teachers Association, published by the Association monthly except January, June, July, and August. Editorial and executive offices, 1201 Sixteenth Street, N. W., Washington 6, D. C. Of the membership dues (see listing below), $3 is for the Journal subscription. Single copies, 50¢. Copyright, 1958 by the National Science Teachers Association. Entered as second-class matter at the Post Office at Washington, D. C., under the Act of March 3, 1879. Acceptance for mailing at special rate of postage provided for in the Act of February 28, 1925, embodied in paragraph (d), Section 34.40 P. L. & R. of 1948. Printing and typography by Judd & Detweiler, Inc., Washington, D. C.

OFFICERS OF THE ASSOCIATION

Glenn O. Blough, *President*, University of Maryland, College Park, Maryland
Herbert A. Smith, *President-elect*, University of Kansas, Lawrence, Kansas
John S. Richardson, *Retiring President*, The Ohio State University, Columbus, Ohio
H. M. Louderback, *Secretary*, Lewis and Clark High School, Spokane, Washington
Robert T. Lagemann, *Treasurer*, Vanderbilt University, Nashville, Tennessee
Robert H. Carleton, *Executive Secretary*, 1201 16 Street, N. W., Washington 6, D. C.

MEMBERSHIP

The membership year coincides with the calendar year. New entries during the fall months extend through the following calendar year.

Regular Membership	$ 6.00
Sustaining Membership*	10.00
Student (college and university) Membership	2.00
Life Membership* Payable in ten annual installments; $150.00 if paid in three years or less.	175.00
Library Subscription*	8.00

* Includes the *Elementary School Science Bulletin* and *Tomorrow's Scientists.*

Coming . . .

in *The Science Teacher*

- Definitions, Didactics, and Deliberations
- "Pressure Areas" in the Classroom
- Functional Scientific Method
- Philosophical Critique of Chemistry Teaching
- 1958 STAR Award Winners

You Can Depend on the GENATRON

● *The MODERN Electrostatic Generator*

THE CAMBOSCO GENATRON serves not only for classical experiments in static electricity, but also for new and dramatic demonstrations that are not performable by any other means. It exemplifies a modern method of building up the tremendously high voltages required for atomic fission, for nuclear research, and for radiation therapy.

Entirely self-exciting the GENATRON cracks into action at the snap of the switch—whose only function is that of starting the motor drive. No auxiliary charging method is employed. Hence, despite an output measured in hundreds of thousands of volts, no hazard is involved, for the operator or for the observers.

An Output of 250,000 Volts—or More!

THE CAMBOSCO GENATRON is designed to deliver, in normal operation, a discharge of the order of 250,000 volts. That figure, a conservative rating, is based on many trials conducted under average conditions. With ideal conditions, a potential difference of 400,000 volts has been achieved.

Modern Design— Sturdy construction and ever-dependable performance distinguish the GENATRON from all electrostatic devices hitherto available for demonstration work in Physics. This powerful, high-potential source, reflecting the benefits of extensive experience in electrostatic engineering, has absolutely nothing but purpose in common with the old-fashioned static machine!

NO FRAGILE PARTS—Durability was a prime consideration in the design of the GENATRON which, with the exception of insulating members, is constructed entirely of metal.

The only part subject to deterioration is the charge-carrying belt, which is readily replaceable.

NO TRANSFER BODIES—In all conventional influence machines, whether of Holtz or Wimshurst type, electrical charges are collected and conveyed (from rotating plates to electrodes) by a system of "transfer bodies." Such bodies have always taken the form of metal brushes, rods, button disks or segments—each of which, inevitably, permits leakage of the very charge it is intended to carry, and thereby sharply limits the maximum output voltage.

It is a distinguishing difference of the GENATRON that electrical charges, conveyed by a non-metallic material, are established *directly upon the discharge terminal.* The attainable voltage accordingly depends only upon the geometry of that terminal and the dielectric strength of the medium by which it is surrounded.

Unique Features of the CamboscO Genatron

DISCHARGE TERMINAL Charges accumulate on, and discharge takes place from, the outer surface of a polished metal "sphere"—or, more accurately, an oblate spheroid.

The upper hemisphere is flattened at the pole to afford a horizontal support for such static accessories as must be insulated from ground. A built-in jack, at the center of that horizontal area, accepts a standard banana plug. Connections may thus be made to accessories located at a distance from the GENATRON.

CHARGE-CARRYING BELT To the terminal, charges are conveyed by an endless band of pure, live latex—a CamboscO development which has none of the shortcomings inherent in a belt with an overlap joint.

DISCHARGE BALL High voltage demonstrations often require a "spark gap" whose width can be varied without immobilizing either of the operator's hands.

That problem is ingeniously solved in the GENATRON, by mounting the discharge ball on a flexible shaft, which maintains any shape into which it is bent. Thus the discharge ball may be positioned at any desired distance (over a sixteen-inch range) from the discharge terminal.

BASE...AND DRIVING MECHANISM Stability is assured by the massive, cast metal base—where deep sockets are provided for the flexible shaft which carries the discharge ball, and for the lucite cylinder which supports, and insulates, the discharge terminal.

The flat, top surface of the base, (electrically speaking), represents the ground plane. Actual connection to ground is made through a conveniently located Jack-in-Head Binding Post. The base of the Genatron encloses, and electrically shields, the entire driving mechanism.

PRINCIPAL DIMENSIONS The overall height of the GENATRON is 31 in. Diameters of Discharge Ball and Terminal are, respectively, 3 in. and 10 in. The base measures 5¼ x 7 x 14 in.

GENATRON, WITH MOTOR DRIVE
Operates on 110-volt A.C. or 110-volt D.C. Includes: Discharge Terminal, Lucite Insulating Cylinder, Latex Charge-Carrying Belt, Discharge Ball with Flexible Shaft, Accessory and Ground Jacks, Cast Metal Base with built-in Motor Drive, Connecting Cord, Plug Switch, and Operating Instructions.
No. 61-705 ..... **$98.75**

GENATRON, WITH SPEED CONTROL
Includes (in addition to equipment itemized under No. 61-705) built-in Rheostat, for demonstrations requiring less than maximum output.
No. 61-708 ..... **$109.00**

No. 61-710 Endless Belt. Of pure latex. For replacement in No. 61-705 or No. 61-708. **$3.00**

CAMBOSCO SCIENTIFIC COMPANY

37 ANTWERP ST. • BRIGHTON STATION • BOSTON, MASS.

LOW-PRICE CLASSROOM AIDS for SCIENCE TEACHERS!

See the Stars, Moon, Planets Close Up!

3" ASTRONOMICAL REFLECTING TELESCOPE

(Famous Mt. Palomar type)

60 & 120 Power—An Unusual Buy!

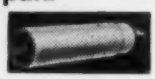
Assembled and ready to Use! You'll see the Rings of Saturn, the fascinating planet Mars, huge craters on the moon. Aluminized and overcoated 3" diameter high-speed f/10 mirror. Telescope comes equipped with a 60X eyepiece and a mounted Barlow Lens, giving you 60 & 120 power. Optical Finder Telescope included. Sturdy, hardwood, portable tripod. Free with scope: Valuable STAR CHART and 272 page "Astronomy Book."

Stock No. 85,050-AC.....$29.50 f.o.b.
(Shipping Wt. 10 lbs.) Barrington, N. J.

Now—See The Satellites

NEW, LOW PRICE "SATELLITER" TELESCOPE

First Time—Only $9.95 Postpaid



Get ready for a terrific sky show as more Satellites are vaulted into space. See thrilling sights with our amazing Satellite Scope at unheard of low cost. Also view comets—use as a Rich-field Scope for viewing star clusters. 5 power—wide 12° field—slight distortion at outer edges because of unusual wide field. Use of high quality war surplus optics makes possible this bargain. Full 2" achromatic objectives—large 9mm exit pupil for night use. Scope is 10" long, weighs less than one pound.

Stock No. 70,150-AC.....$9.95 Postpaid
Mount for above scope Stock No. 70,152-AC.....$9.00 Postpaid

We are the manufacturers of the Famous Moonwatch Satellite Telescope

FINE, AMERICAN-MADE INSTRUMENT AT OVER 50% SAVING

STEREO MICROSCOPE

Up to 3" Working Distance—Erect Image—Wide 3 Dimensional Field

Ideal for classroom or home use; for inspections, examinations, counting, checking, assembling, dissecting. 2 sets of objectives on rotating turret. Standard pair of wide field 10X Kellner Eyepieces give you 23 power and 40 power. Additional eyepieces available for greater or lesser magnification. Helical rack and pinion focusing. Interpupillary distance adjustable. American made! 10 DAY FREE TRIAL . . . complete satisfaction or your money back.

Order Stock No. 85,056-AC Full Price—$99.50 f.o.b.
(Shipping weight 11 lbs.) Send Check or M.O. Barrington, N. J.

BUILD A SOLAR ENERGY FURNACE

Wonderful Geophysical Year School Project

Build your own Solar Furnace for experimentation—many practical uses. It's easy—inexpensive. Use your scrap wood. We furnish instruction booklet. This sun powered furnace will generate terrific heat—2000° to 3000°. Fuses enamel to metal. Sets paper aflame in seconds. Use our Fresnel Lens—14¾" diameter..f.l. 14".

Stock No. 70,130-AC pkg. of 1.....$6.00 Postpaid

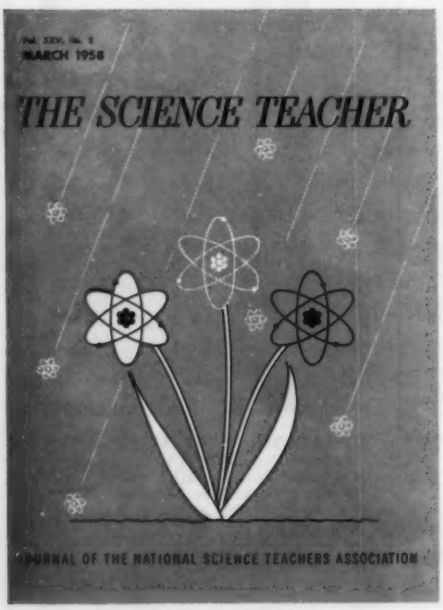
WRITE FOR FREE CATALOG-AC

Huge selection of lenses, prisms, war surplus optical instruments, parts and accessories. Telescopes, microscopes, satellite scopes, binoculars. Infrared snooperscopes and parts, reticles, mirrors. Ronchi rulings, dozens of other hard-to-get optical items. America's No. 1 source of supply for Science Teachers, Photographers, Hobbyists, Telescope Makers, etc. **Ask for Catalog AC**

Order by Stock No.—Send Check or M.O.—
Satisfaction Guaranteed

EDMUND SCIENTIFIC CO.
BARRINGTON, NEW JERSEY

THIS MONTH'S COVER . . .



could almost be a fantasy, and why not, since spring is nearly here? Actually, it's not so much of a fantasy as it seems. It is an interpretation of this issue's two articles in the continuing series being provided by the U. S. Public Health Service. This month's articles take up radioactivity and how classroom demonstrations therefrom can be evolved. This month's cover highlights the vegetation and rainout activities developed from the Taft Sanitary Engineering Center studies which are the subject of the current articles (beginning on page 76).

As a result of the first two articles in last month's issue of *TST* on this unique program of collaboration between research scientist and high school science teacher, *TST's* editors have already received a number of requests for reprints. Don't ask for them now. The plan of the U. S. Public Health Service is to reprint the articles, at least in a series of four issues as published in *The Science Teacher*, beginning in late May—or, in practical terms, available for fall classroom work. In the meantime, additional articles will be published on this Public Health Service program during the spring—and probably in the fall. In the Cincinnati schools, the program is already showing results—as special photographs taken for this issue of *TST* demonstrate.

the big 4 for your high school science program

▶ BIOLOGY

Kroeber • Wolff • Weaver

A colorful text that presents the subject on the basis of the biology of man and his relationship to other animals and to plants.

▶ CHEMISTRY IN ACTION Third Edition

Rawlins and Struble

A colorful, modern revision with thorough coverage of the field. Correlated film list, new end-of-chapter problems.

▶ PHYSICS—The Story of Energy Second Edition

Brown and Schwachtgen

Highly praised for its inductive approach and its handling of mathematics.

and for your lab . . .

SEMIMICRO LABORATORY EXERCISES IN HIGH SCHOOL CHEMISTRY

Second Edition—**Weisbruch**

The most widely used high school semimicro manual in print. Varied experiments fit any high school course.

D. C. HEATH
and Company

Sales Offices: Englewood, N. J.
Chicago 16
San Francisco 5
Atlanta 3
Dallas 1

Home Office: Boston 16

"If it is to be learned effectively science must be experienced. It must be learned and not learned about. Science is so close to the life of every boy and girl that there is no need to confine its study to the reading of textbooks or listening to lectures. Wherever you may go in the world, science is an intimate part of the environment—living things, the earth, and sky, air and water, heat and light and forces such as gravity. No teacher need ever be without first-hand materials for the study of science."—From the Introduction.

UNESCO

Source Book for Science Teaching

This book shows how inexpensive, everyday materials can be used to develop an exciting science program for the upper grades and junior high school. Over 700 class demonstrations, pre-tested by experts, are presented and hundreds of illustrations show just how to succeed. Among the subjects discussed are experiments and materials for the study of

- Plants
- Animals
- Rocks, soils, minerals, and fossils
- Astronomy
- Air and air pressure
- Weather
- Water
- Machines
- Forces and inertia
- Sound
- Heat
- Magnetism
- Electricity
- Light
- The human body

Each experiment is accompanied with a short descriptive paragraph, clearly outlining each step to be taken, and, in most cases, a simple line drawing.

222 pages. **Cloth, $3.00**

International Documents Service
COLUMBIA UNIVERSITY PRESS
New York 27, New York

International Documents Service
COLUMBIA UNIVERSITY PRESS
New York 27, N. Y.

Please send me .....copy(ies) of UNESCO SOURCE BOOK FOR SCIENCE TEACHING.

[ ] Payment enclosed. We pay postage. [ ] Please bill me.

Name.....

School.....

Address.....

City..... Zone..... State .....

Signature .....

Editor's Column

I've just had a chance to "sneak preview" some results of the current NEA study of teacher supply and demand. Naturally I looked first at "how we're doing" in science.

Well, at first glance it appears that things are brightening up. The colleges and universities expect to give us next June, 5852 new teachers with major preparation in science and the qualification of having met standard certification requirements of their respective states. This is an increase of 18.8 per cent over the 1957 output of 4926. This year's crop breaks down into 3011 for general science,* 1999 with a major in biology, 628 with a major in chemistry, and 214 with a major in physics.

We can take some satisfaction in pointing out that these people must have decided on preparation for teaching long before Sputnik I's ascent on October 4, 1957. There must have been some influences toward teaching acting on these people three to five years ago; career decisions are not reached or new teachers made overnight.

However, there persists a very dark side to the coin. Schools will still have to compete with industry for the services of these young teachers. (After all, they're *not* dumb bunnies with courses only in "education" on their records, and they *can* get jobs in scientific research and development!)

Last year only 62.8 per cent of the June crop of new science teachers actually entered teaching in September. If this figure increases to as much as 70 per cent this year (an optimistic estimate) and if school officials again need to hire as many new science teachers as last year (about 8500), then it is obvious they will be beating the bushes for some 4000 or more science teachers from sources other than the 1958 college graduates.

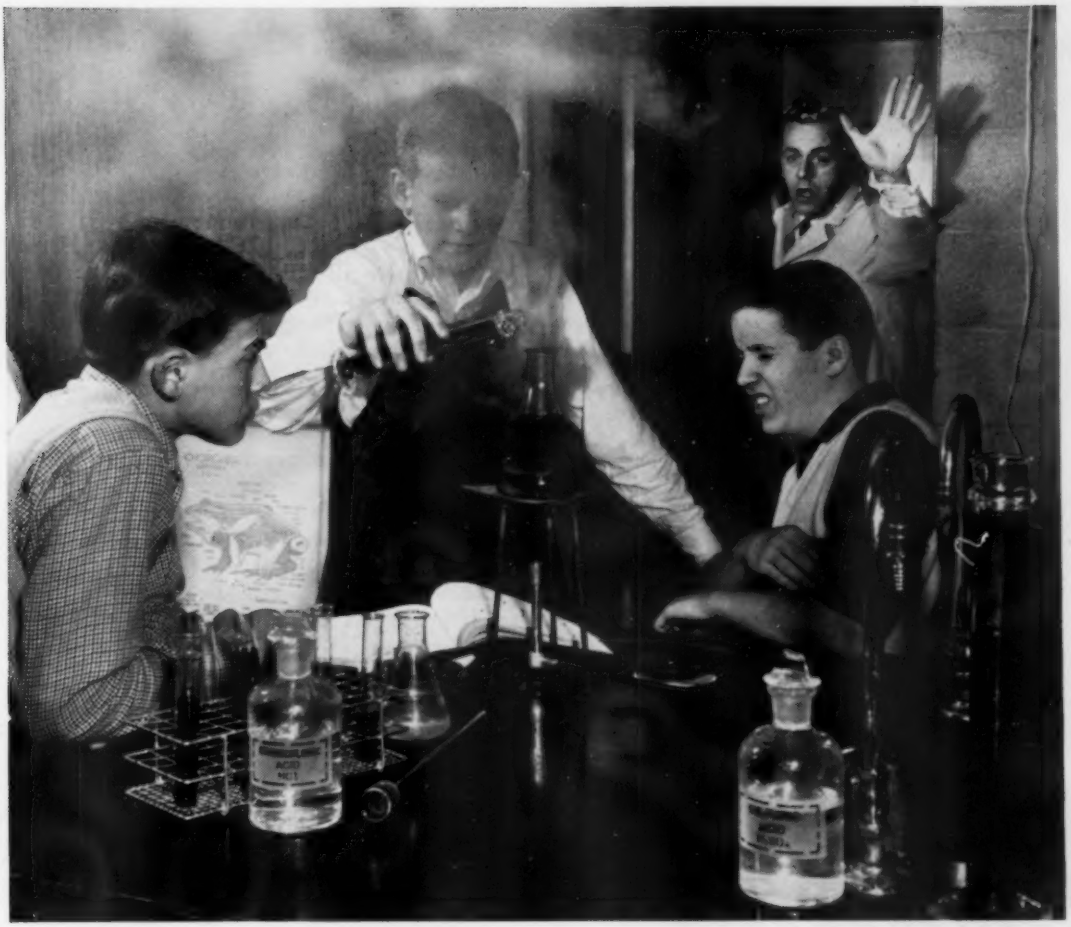
The competitive position of schools is perhaps indicated by a letter we received from a young man asking whether NSTA could help him locate a good-paying teaching position. With three years of teaching experience and a National Science Foundation Summer Institute on his record and an NSF Academic Year Institute (plus a Master's degree) to his credit come this June, he now has eight job offers—with the highest salary attachment being $4200! Small wonder he says, "I hope I can always teach, but at $4200 I am being forced into industry."

There's the nub of the problem.

Robert H. Carleton

---

* It is important to point out that practically all of these 3011 "general science" teachers have major academic preparation in at least one field, usually biology, chemistry, or physics. This means that many more teachers are prepared in these special fields than the other figures in this series woud suggest. Increasingly, prospective science teachers are being urged to obtain breadth in science as well as depth in at least one field. In such cases, the teachers are then reported as "general science," which really masks their full preparation in the special field.



Will it break before you get there?

The three best students in your class. But, that's the trouble. They're always striking out on their own . . . trying their own experiments.

But there is one big factor in *their* favor—your efforts to get them the safest equipment with which to work.

That PYREX brand flask, for example. It can take heat and heat shock. It's made heavier and stronger than flasks fashioned of ordinary glass that can't take heat.

Or the graduated cylinder—it's mounted on a stable, hexagonal base; has a built-in bumper at the top to cut down tip-over breakage. One large university tested them, found their students broke only *one* PYREX cylinder to *three* of a competing brand.

Specifying PYREX brand is smart buying. Less breakage means lower cost over the years. And less likelihood of accidents.

Write for your free copy of *This is Glass*. Its sixty-four pages describe what glass is, how it's made, where it's used. Enjoyable reading.

CORNING GLASS WORKS
77-3 Crystal Street, Corning, N.Y.
Corning means research in Glass

T.M. REG. PYREX U.S. PAT. OFF.

PYREX® laboratory ware
. . . the tested tool of modern research

The UNIVERSITY OF COLORADO

Boulder, Colorado

announces the 1958

SUMMER SESSION

June 13—August 23

- **NEW GRADUATE DEGREE PROGRAM IN SCIENCE AND MATHEMATICS.**

  In addition to the regular graduate programs leading to the Master of Arts or Science or the Doctor of Philosophy degrees in various fields of science and mathematics, the University is pleased to announce a program leading to the degree Master of Basic Science. This degree is designed especially for teachers and other persons needing a broad background in science and mathematics. The requirements for the degree can be met in part by presenting a minimum of 30 approved semester credits from the sciences and mathematics.

- **COURSES OF PARTICULAR INTEREST TO TEACHERS.**

  Biol. 403—Recent Advances in Biology for Secondary Schools.
  Geog. s430—Conservation Education Workshop.
  Physics 311—Modern Views of Physics.
  Math. 470—Teaching of Secondary School Mathematics.
  Math. 471—Mathematics Workshop in Teaching Problems.

  In addition to these special courses, each field of science will offer a standard program. The Department of Chemistry will offer a full year's courses in each of the basic fields of Chemistry: general, analytical, organic, and physical. Summer field Geology courses will be offered as well.

- **For further information and a Summer Bulletin, write today to the Dean of the Summer Session, McKenna 8, University of Colorado, Boulder, Colorado**

TESTA WIDE FIELD MICROSCOPE

A Sturdy, Standard-sized, American-made Microscope with WIDE FIELD and 15x, 45x, 75x MAGNIFICATION for Live Nature and Whole Specimen Study in or outdoors.

Unusual versatility in use is one of its outstanding features. In addition to normal position for desk work, arm or tube may be inclined or reversed to operate in any direction of a 360° circle. Tube removable for field trips.

Price of Model A, illustrated, is $54.85. This includes not one but all three magnifications, 15x, 45x and 75x, coarse and fine focusing. Achromatic objectives. Send for Bulletin A-145.

If interested in our complete line of quality school microscopes at low cost, send for bulletin M-80.

Please address Dept. ST

TESTA MANUFACTURING CO.

10122 E. Rush Street, El Monte, California

Readers' Column

In the November Editor's Column, Mr. Carleton wrote that in his Physical Science Study Committee activities, he has "urged a heads-in-the-stratosphere, feet-on-the-ground approach." I am wondering whether the PSSC proponents find themselves losing sight of terra firma while trying to keep their heads in the clouds.

My own impressions derive mainly from personal reaction to the PSSC reports published in the November *TST*. I am writing my reaction for two reasons: one, the Editor's Column solicitation; the other, a realization of the impact this project may have on the future of science teaching.

I am gratified to see evidence of a real attempt to teach physics as a living science. This is very good, and this aspect of the program deserves every support and encouragement.

The assumption is made, apparently, that a basic course in physics needs to be held together from beginning to end by a unifying concept of energy. There are, however, many advantages, practical and pedagogical, to the classical subdivisions. One should hesitate to discard this time-tested organization for a course of study in which the elements are selected and made to fit an arbitrarily preconceived unifying theme.

I can visualize the glee of the taxpayer in the promise that better physics can be learned with pieces of equipment whose cost varies from zero to pennies, or, at most, a very few dollars. I do admit that a soda straw balance that can weigh a fly's wing is very cute. But I fail to see where this fits in in a science course at the senior high school level. To be sure, the straw and the milk container are free of cost. In reality, however, the instrument turns out to be a very expensive gadget. What of the overhead cost of the school plant and of the teacher time? (Incidentally, the student uses shop equipment in constructing this and other pieces of equipment.) And what value the time of the youngster devoted to such construction projects? How much physics does the student learn to justify this investment of *his* time? The apparatus is not even his personal contribution. Is he here to be subjected to the variously criticized cookbook methods, in another guise, to be sure, in producing these gadgets? A $20 agate-bearing platform balance affords him the thrill and satisfaction of using an accurate, professional piece of equipment and an opportunity to develop a skill which will facilitate his subsequent use of such a tool in wrestling with challenging physical problems.

The course is now in its honeymoon stage. Participating teachers are spurred with initial enthusiasm and they have been freed of other common teacher duties.

Yet I am told that, in one school at least, the teacher himself is devoting much of his free time to the actual construction of the "inexpensive" pieces of apparatus. If this is true, and I have no reason to doubt it, it indicates an unresolved problem in the program. How will this teacher fare when he finds himself in a normal teaching situation where he is called upon to carry a full teaching load under a regular bell schedule.

I could wholeheartedly support a program which offers the young student unhampered access to basic tools of physics, both physical and mental. Mental tools will be acquired under the influence of inspirational teaching and teaching which will repeatedly confront the student with challenging problems and point out uncharted areas. It will provide co-curricular and extracurricular time and facilities for the student to apply physical and mental tools in attempts to delve into unknown, to the student at least, facets of our physical world.

JOSEPH SINGERMAN
The High School of Commerce
New York City

The articles on the Physical Science Study in the November 1957 issue of *TST* are extraordinarily exciting.

L. W. CRONKHITE
Vice-President, Baird-Atomic, Inc.
Cambridge, Massachusetts

AMERICAN COLLEGE BUREAU

28 E. Jackson Blvd., Chicago 4, Ill.

Teachers in the different fields of Science have rare opportunities through our office for positions in colleges and universities. As you know, they are asking for those who are exceptionally well trained in each of the different fields of Science.

OUR SERVICE IS NATION-WIDE.

A GENERAL SCIENCE TEXTBOOK SHOULD BE AS WELL WRITTEN AS A GOOD NOVEL

A general science textbook should have a flowing style, it should be as timely as today's newspapers, it should be fun and meaningful to read. A startling statement? Yes . . . but a statement good teachers have approved wholeheartedly. That is why Rand McNally has published "GENERAL SCIENCE TODAY."

General Science Today

- is aimed throughout to present general science to the student in terms of the visible, tangible world he knows
- goes beyond the formal training and rote learning of the traditional general science course
- acquaints students with the science they will need to know to reach their goals in the adult world
- challenges the ability of every pupil, no matter what his capacity
- will lighten your work load and help you do the teaching job you want to do

Like to see an evaluation copy? If so, please write

RAND McNALLY & COMPANY

Box 7600 • Chicago 80, Illinois

The Welch **MAGNETIZER**

Free from shock hazards—Simple design

Safe and Foolproof

Strongly magnetizes Bar or Horseshoe Magnets

No. 1844

Powerful permanent magnets of either the horseshoe or straight-bar type can be made in an instant with this unique trouble-free magnetizer. It operates on any 115-volt A.C. line and is entirely free from fire and electricity shock hazards.

The principle is simple. Two open-core coils are mounted vertically on a soft-iron plate on a 7x9½-inch base along with a momentary toggle switch and a special fast-acting 6-ampere circuit breaker, all connected in series. When the two arms of a horseshoe magnet, for example, are inserted in the coils, the circuit breaker is set, and the toggle switch is pressed. The circuit breaker opens the circuit on a peak of the alternating-current cycle, thereby magnetizing the specimen. Which end is the N and which is the S pole may be determined with a compass. Poles can be reversed simply by trial. When bar magnets are to be made, two must be used, with a soft-iron keeper connecting their top ends.

The center opening of each coil is 3 cm in diameter, they are 5.6 cm between centers, and 11 cm high. A connecting cord and plug are provided.

No. 1844. Each, $24.85

W. M. WELCH SCIENTIFIC COMPANY

DIVISION OF W. M. WELCH MANUFACTURING COMPANY

ESTABLISHED 1880

1515 Sedgwick Street, Dept. T Chicago 10, Illinois, U. S. A.

Manufacturers of Scientific Instruments and Laboratory Apparatus

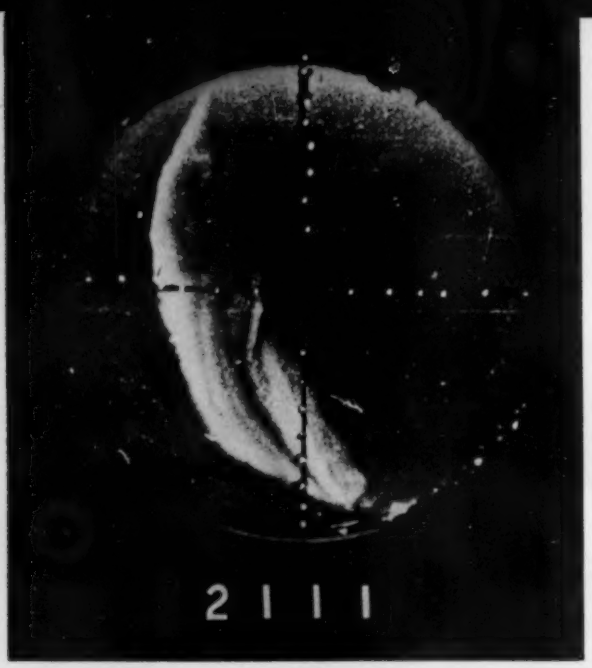
IGY UPPER ATMOSPHERE STUDIES

To the Edge of Space

By ALAN H. SHAPLEY

Chief, Sun-Earth Relationships Section, Central Radio Propagation Laboratory, National Bureau of Standards, Boulder, Colorado

THE high atmosphere is at once the shield and the veil of man in his journey through space. It insulates man from lethal solar radiations and, at the same time, screens much that goes on in the heavens from man's eyes. Indirect techniques and observations have taught us that solar activity often causes disturbances in the high atmosphere, blacking out radio signals and interfering with electronic navigational and guidance systems. It has long been believed that solar events are connected with the



Photograph of aurora taken with an all-sky camera on the roof of the Geophysical Institute, University of Alaska. Such cameras photograph the entire visible sky at frequent intervals during the night. In the upper left quadrant is an image of a tower on the building roof. The perpendicular rows of lights indicate direction; they are attached to a framework above the camera. North is to the right. The number at the bottom, 2111, indicates the time the photograph was taken—9:11 p.m.

scintillating auroral spectacles, the northern and southern lights, and with other high atmosphere phenomena. More recently it has been thought that events in the high atmosphere influence weather and air movements at lower levels.

The progress of knowledge of upper atmosphere phenomena is slow. But with new instruments and techniques, scientists during the International Geophysical year are already speeding up the accumulation of data and the gathering of new insights. Here are some questions they seek to answer:

How does solar activity cause magnetic storms and radio blackouts?

Why do only some solar outbursts cause these effects, and why do they occur occasionally when the sun appears to be quiet?

Do upper air winds help produce the great electric currents generated during magnetic storms?

Do magnetic fields exist in space between the upper atmosphere and the sun? If so, how do they affect streams of solar particles approaching the earth?

How far does the atmosphere extend?

Exactly how are auroras caused and what is their relationship to other upper atmosphere phenomena?

Structure and General Character of the Earth's Atmosphere

Though man is concerned primarily with the first few hundred feet of the earth's atmosphere—where the bulk of his population is concentrated—scientists now believe that the atmosphere reaches out thousands of miles from the surface. Despite this great extent, more than half the total mass of our atmosphere lies below 20,000 feet and only about one per cent of it exists above 100,000 feet.

The earth's atmosphere consists of a series of roughly concentric layers, or "spheres," differing from each other in density, pressure, temperature, electrical charge, chemistry, and behavior. The margins of these layers fluctuate with both time and geographic location.

The Atmospheric Layers. The lowest atmospheric layer, the *troposphere*, where the components of our everyday weather prevail, extends to altitudes ranging from about five miles at the poles to 12 miles at the equator. The troposphere is characterized by temperatures that decrease with altitude at an average rate of about 19° F per mile; by great quantities of water, water vapor, and ice; by cloud formation; and by turbulent air in which convection is active. Above the troposphere is the *stratosphere*, a cold, virtually cloudless layer of thin air moving predominantly horizontally and eastward. Temperatures are low and more or less constant. The stratosphere reaches a height of about 35 miles.

From this level, the upper atmosphere stretches outward for distances possibly greater than 10,000 miles. The upper atmosphere may be divided broadly into the *ionosphere* and the *exosphere*. The ionosphere may extend to a height of about 600 miles. Beyond it lies the vast, near-empty exosphere.

The ionosphere consists of several layers of electrically charged (or ionized) gases which reflect radio waves back to earth, making possible the sending of radio signals for long distances. This is also where auroras form, most meteors begin their fiery plunges, and many of the dangerous radiations that continually bathe our planet—such as cosmic rays, X rays, and ultraviolet light—are absorbed.

Ionization of the ionosphere results from the action of X rays and ultraviolet radiation from the sun literally tearing electrons from the neutral air particles and leaving them with a positive electrical charge.

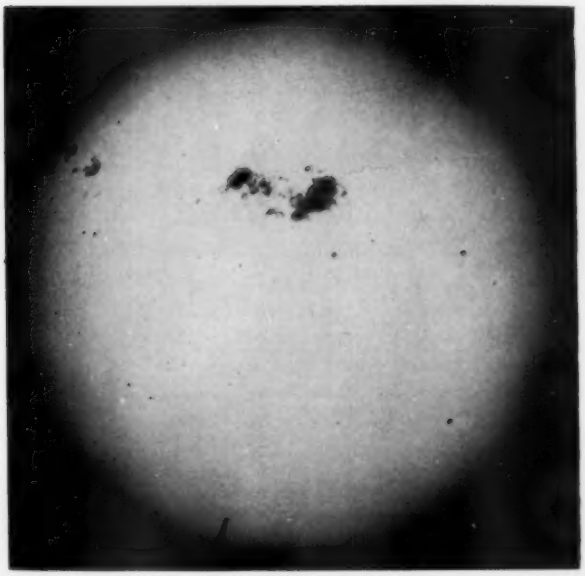
The lowest ionospheric layer, the D layer, is only slightly ionized and reflects radio waves with frequencies considerably below those in the standard broadcast band, absorbing a large portion of the waves of higher frequency. It exists only during daylight at heights of about 35 to 50 miles. The next higher layer, the E layer, reflects waves with frequencies between about 500 and 1500 kilo-

cycles, the approximate range of the standard AM band (medium frequency) on home radio sets. This layer is 55 to 85 miles high.

Above the E layer, between heights of about 85 and 220 miles, lies the F layer. This layer normally reflects high-frequency radio waves, between approximately 1500 kc and 15 megacycles. At night there is only one F layer, but during the day it exists as two separate layers called the F_1 (100-125 miles) and the F_2 (155-220 miles) layers. Radio waves of frequencies higher than 30 mc penetrate the entire ionosphere and are lost in space.

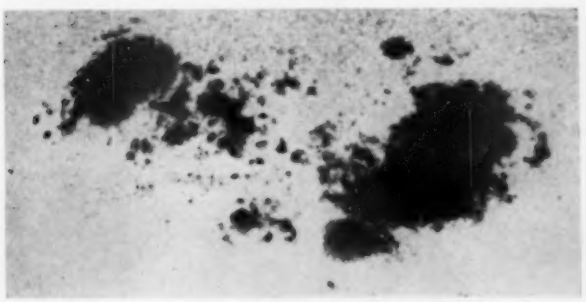
Unexplained seasonally occurring patches—cloud-like masses of intensely ionized air—which reflect medium-frequency waves have also been detected in certain geographic locations. These usually short-lived, rapidly moving clouds occur in the E layer and have therefore been named *sporadic E.*

The exosphere is the extremely tenuous outermost layer of the atmosphere. At its as yet undetermined outer edge it blends imperceptibly into the immense void of interplanetary space.



Solar disk and enlargement of great sunspot group of April 7, 1947. Such solar disturbances commonly are associated with auroras, magnetic and ionospheric storms, and radio blackouts.

MT. WILSON-PALOMAR OBSERVATORIES PHOTOGRAPHS



AFTER J. P. HAGEN, U.S. NAVAL RESEARCH LABORATORY

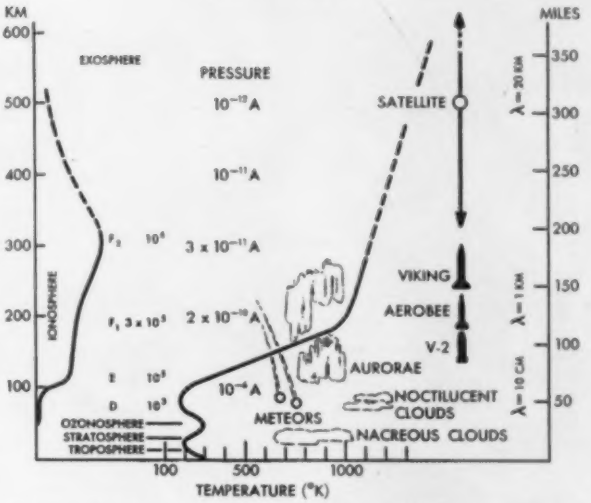


Diagram showing upper atmosphere characteristics. Line representing ionosphere indicates relative ionization of D, E, F_1, and F_2 layers (also shown numerically). Pressures are in atmospheres (A), equal to 14.7 lbs per square inch at sea level. Temperatures are in degrees Kelvin (K), equivalent to degrees centigrade but with the zero point of the scale at —273° C (absolute zero). Lambda (λ) represents the mean distance particles travel without collision.

Other zones such as the *chemosphere, thermosphere, ozonosphere,* and *mesosphere,* have been delineated by various scientists. These are either coextensive with one or another of the main zones, or are regions within the main zones possessing some dominant characteristic, suggested by their names.

General Physical Characteristics of the Upper Atmosphere

Man has now gained the ability to make direct measurements in the upper atmosphere with the help of instrumented rockets and satellites. But even before he perfected these new techniques, man had learned a great deal about this hitherto unreachable segment of his planet's environment. Observations of the movement of meteor trails and the 50-mile-high noctilucent clouds have stimulated speculation about the direction and velocity of upper air winds for centuries.

The earliest record of observations of upper atmosphere winds was made in 32 B. C. by the Chinese, who noted the movements of the persistent trains of particularly bright meteors. It was not until the late 19th century, however, that systematic observations to determine upper air circulation were begun.

(Continued on page 98)

a PRO for the PLANNED PROGRAM

By GRACE C. MADDUX

Science Supervisor, Cleveland, Ohio, Public Schools

Shall the elementary science program be planned or incidental? This question has been discussed pro and con at many meetings and there is no unanimous agreement. Perhaps this is a healthy situation since it keeps us alert to the problem and makes us evaluate our objectives in science teaching.

Dr. Harold C. Urey recently made some very thought-provoking comparisons between the European system of education and our own.* He said most of the men on his research staff were foreign-born and foreign-trained. He implied that our educational system was not rigorous enough.

We certainly would not be happy with the rigid Russian system, but perhaps we need more definite goals of accomplishment in our schools.

Many science educators have listed objectives for elementary science. I could not improve on them, but I submit these few for consideration.

1. One objective of the elementary school should be to make science so interesting that children will want to continue it in junior and senior high school. In this connection I would like to comment on a study made by Edward J. Uber of Von Steuben High School, Chicago, which was reported in the *Chicago School Journal*, June 1957. As a high school teacher he was interested in finding reasons why so few students elected science courses in high school. He went back to their elementary school experience to see if they could shed any light on the subject. He asked them what they liked about their elementary science. Some reported little experience in elementary science; others mentioned a liking for astronomy, animals, plants, physiology, electricity, weather, geology, charts, discussion, oral reports, experiments, trips. To the question, "What did you dislike?" the following are some of the answers: Too few experiments, too little discussion, too much written work, too little science, too many reports, not enough books, same thing each year, too many collections, too little explanation, too many repetitions, a long drawn-out topic for a whole semester.

Mr. Uber is quite aware that definite conclusions cannot be drawn from such questions in just one school. However, I have a feeling some of these

This article is based on a talk given December 28, 1957 in Indianapolis, Indiana at the National Science Teachers Association annual winter meeting.

* Annual convention, Central Association of Science and Mathematics Teachers, Chicago, Ill., November 29-30, 1957.

answers might be repeated if other high school students were questioned. An interest created or killed in the elementary school cannot help but influence the child's later reaction to science.

2. Elementary science can help the children find answers to the questions they ask.

3. It should not stop at their questions, however, but it should open up new areas of interest which will arouse further questions.

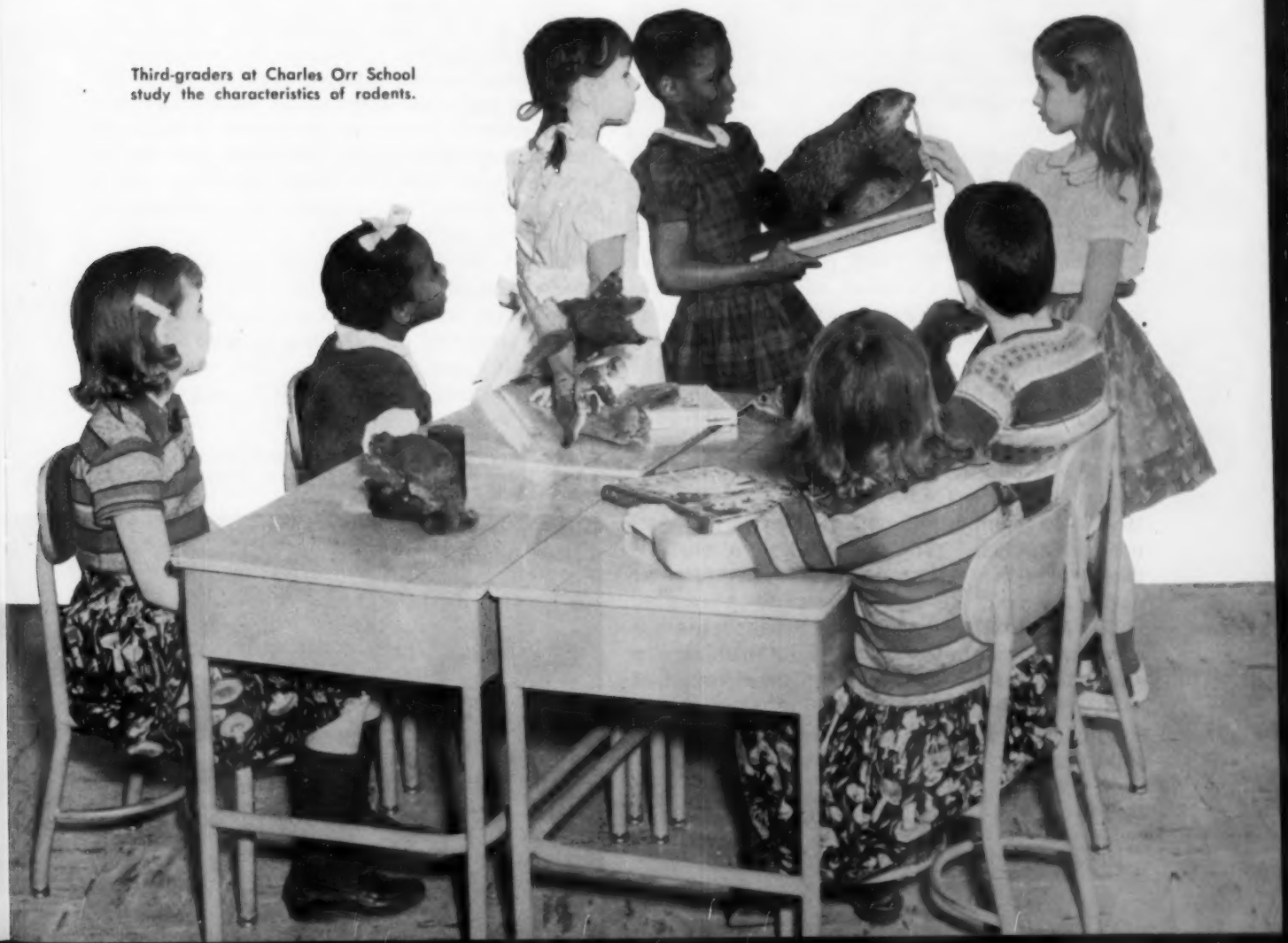
4. Elementary science should be taught so that children use all the tools of learning to solve or answer their questions or problems—observation of real things, books, experiments, and visual aids.

I have always been in favor of a planned program for it seems to me to more nearly meet these and other objectives. A planned program does not need to be rigid; it should certainly have flexibility within the framework of the over-all plan so that the teacher can adapt it to the ability of her class.

The following are some of my reasons for preferring a planned program:

1. Science is an orderly body of facts. A planned program can be so arranged that the children progress from simple understandings in the primary grades to more complex ones in the upper grades. This kind of arrangement will help the children to appreciate the fact that an understanding concerning weather, for instance, will depend on many basic concepts in several areas of science. They should realize that at the sixth grade they are able to understand much more about the "why" of our weather than when they were in the first grade, but they also should realize that to answer the question completely will take much more information which they will gradually build as they continue in science. It is important that children leave

The Cleveland (Ohio) Public Schools elementary science program is considered outstanding in the nation. The diversity of activities offered by the program at different grade levels is demonstrated by the pictures on these pages. The photographs are by the Bureau of Visual Education, Cleveland Public Schools.



Third-graders at Charles Orr School study the characteristics of rodents.

What causes rain? In a Gracemount School second-grade weather unit, the pupils watch water condense on an ice cube tray.

the sixth grade, not with the feeling that they have all the answers, but in anticipation of finding out more and more about their environment. Additional knowledge should inspire more questions and the desire to explore further.

A planned program helps children to see the expanding concepts in science and also to see interrelationships in the various areas of science.

2. A program based on incidental science can lead to repetition from year to year. Mr. Uber reported that the students disliked the repetition in their elementary science. Some areas of interest will never be opened to children for exploration if just the incidental approach is used. In a large city system, such as Cleveland, with a mobile population it seems especially necessary to have a plan. We happen to begin our fall semester in the sixth grade with a geology unit involving changes in the earth's surface, rocks, and prehistoric life. A child moving to another district can pick up the thread in the new school and have a feeling of security If he should arrive in the middle of a unit on electricity, for instance, he would be much confused. I realize that in communities of stable population this does not present such a problem. In some of our districts there is at least a 50 per cent turnover during the year.

3. We are all aware of the fact that the average elementary teacher has had very little training in science. She feels insecure. A planned course of study certainly gives her more of a feeling of security as it gives her the basic understandings and suggests methods for helping children arrive at these understandings. Many teachers even hesitate to follow up incidental questions of children because of their own lack of knowledge in science.

I have watched many of our beginning teachers develop a background in science as well as good teaching techniques. I feel sure that our course of study helped in each instance, since content is outlined and activities suggested. A teacher with little or no science training in the school of education (and that seems to be the rule rather than the exception) is at a loss to know "what" as well as "how" to teach. In such cases it often results in just reading the textbook.

One of the most outstanding examples of the development of a good teacher from scratch happened just a few years ago in one of our schools. Miss X graduated with training to teach secondary mathematics and gymnasium. She was assigned to an elementary school to teach in a departmental

Sixth-graders at East Cork School demonstrate the moon's casting a shadow on earth during an eclipse.

science program. She objected violently to the assignment, but her principal and I promised to help. We did help and she did have the course of study. She found she liked the subject and took summer courses even though she did not need the credit. In two years I sent visitors to see her teach and after five years we transferred her to the science curriculum center. She has developed into a very creative teacher. I feel sure that the course of study was one factor in giving her a good start.

I asked one of our science teachers, with about eight years of experience, to comment on his reaction to a planned program. This is his reply.*

I have found the planned science program to be exceedingly helpful, both as a beginning teacher and as an experienced one, for these reasons:

1. It provided me with a starting point—a place to begin my program, that would be natural, interesting, and successful.
2. Once started, the plan suggested areas of study which were based on the concepts already learned. It gave intelligent direction to my program based on the needs and abilities of the children.
3. It provided me with a sense of security. I knew where to begin, where I was going, and what to do when I got there.
4. My science teaching was organized on the basis of experimentation by expert teachers. I was deriving the benefits of the combined efforts of master teachers who had done the research necessary to determine what areas of science children could, would, and should understand.
5. With a plan of action already organized for me, I could then devote my time and energy to supplementing, enriching, and adapting that plan. If no plan were available, all my energy would certainly be used up in a futile attempt to decide what to teach and when to teach it.

Another teacher I asked put it this way:

> I have learned a lot of science and techniques for science teaching in a practical and economical way, because I have had at my disposal a specific plan which I could apply to the needs of the children I taught.

4. The science course of study needs to be evaluated and revised as new discoveries and needs arise. The scientific advances of the past year are a good example. In Cleveland we have appointed a committee of teachers to take a look at our course of study. Children are air- and space-minded these days and perhaps many of the understandings we develop under other headings may become part of a unit developed from children's interests in the space age. A planned program need never be a static one.

A radio lesson on magnetism intrigues fourth-graders at East Clark School.

Felt discs on a flannel board provide Gracemount School sixth-graders with a model of an atom.

5. An incidental program is likely to follow either the interests of the teacher or the most vocal member of the class. This does not provide a well-rounded program or one that meets the interest of various children in the class. Children's interests will vary and during the year some part of the program will be of special interest to the different individuals. Youngsters sometimes develop an interest after they have been exposed to some phase of the science program.

When I was teaching at the curriculum center several years ago we took frequent surveys to try to determine children's interests. We usually found physical science units ranked first, animals second, and plants third. Even though children are not

(Continued on page 105)

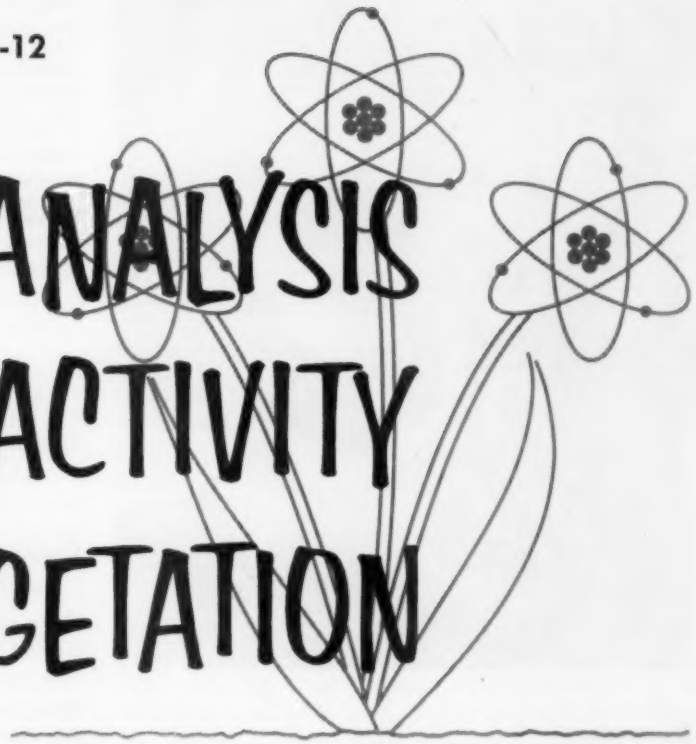
* Alfred Aiello, Supervisory Assistant, Miles Standish School, Cleveland, Ohio.

From Research to Classroom Laboratory...

This and the following article continue the series of demonstrations on the science and engineering of man's environment for healthier living (pages 15-24, February 1958 issue of *The Science Teacher*). The demonstrations are the result of a distinctive program of collaboration between key secondary school science teachers in Cincinnati, Ohio and members of the staff of the Robert A. Taft Sanitary Engineering Center in Cincinnati—the research arm of the Division of Sanitary Engineering Services of the U. S. Public Health Service, Department of Health, Education, and Welfare.

Under the guidance of Lloyd Setter, assistant chief of the Radiological Health Program at the Sanitary Engineering Center and coauthor of this article, Edwin Smith, seated, physics teacher at Cincinnati's Withrow High School, operates a counter measuring radioactivity.

A Teacher-Pupil Activity for Senior High Science Grades 11-12



ANALYSIS OF RADIOACTIVITY IN VEGETATION

By T. HANDLEY DIEHL
Cincinnati, Ohio, Public Schools

and L. R. SETTER
Senior Scientist, Robert A. Taft Sanitary Engineering Center

Background

Among the many naturally occurring radioactive elements, potassium seems to be the most abundant. It occurs almost everywhere and to the extent of 0.011 per cent of the natural element. The total amount in which it is present in all the ocean water of the world is estimated to be close to $5 \times 10^{+11}$ curies or about 3×10^{-13} curies per ml. Since the advent of artificial transmutation of the elements by means of nuclear reactors and nuclear testing, almost every element in the periodic chart is being produced including large quantities which are radioactive. Some of this has found its way into the soil by means of rainout or snowout. The experimental technique which follows is adapted from procedures used by the Robert A. Taft Sanitary Engineering Center to determine to what extent radiation has been taken up by the vegetation. Most of these procedures were worked out by L. R. Setter, A. S. Goldin, G. R. Hagee, and C. P. Straub, all members of the Engineering Center staff.

If samples of vegetation are collected after a rain, much of the activity will be a result of the rain bringing down daughters from naturally occurring radioactive isotopes. However, it is possible, if counting proceeds over a period of time, to calculate that activity which remains in the vegetation. The easiest vegetation to collect are grass cuttings which are gathered immediately after a lawn has been cut.

The Taft Engineering Center found in their work that radiation in vegetation was two to 390 times as active as the more recent rains they had checked. They think this partly due to simple physical adsorption or metabolism. They not only made checks on lawn cuttings as suggested here, but also on cones from fir trees, flowers grown outside, and leaves from trees. Even the fallen leaves in the autumn were raked, collected, and counted. Those who are interested may find this a stimulating study in their own locality.

Statement of Problem

To make a study of the techniques of preparing a vegetation sample for counting and to study the age of the nuclides in the samples obtained.

What Cincinnati high school science teachers are observing at the Taft Sanitary Engineering Center is already being translated into classroom laboratory activities as is shown by the photographs on these two pages and page 81, lower right. The student at work is Ronald Tucker, a junior at Cincinnati's Central High School. Left, a planchet containing ash washings is placed in a drying oven; evaporation will leave an even deposit of solids on the planchet for counting. Below, to demonstrate fallout or uptake, cuttings from lawn or plant leaves are ashed in a crucible to concentrate any radioactive substances present, preparatory to counting. Opposite page, student Tucker surveys the array of equipment he is using in studying rainout, fallout, and plant uptake of radioactivity.

PUBLIC HEALTH SERVICE PHOTOS BY DON MORAN

Equipment

A. A scaler or count-rate meter with a side window and an end-window G-M tube
B. Boxes for collecting the vegetation samples
C. Grass cuttings from a freshly mowed lawn for samples
D. Planchets or bottle caps for counting
E. Drying oven or infrared lamps
F. Evaporating dish; tripod; pipestem triangle; Bunsen burner
G. Rubber policeman

Procedure

1. Collect several grass cutting samples in the boxes selected for that purpose.
2. Obtain the weight of the sample by weighing the box first and then the box with the cuttings. By subtraction the weight of the sample can then be determined.
3. Insert a side-window tube into the box of grass cuttings. Move the tube throughout the sample to obtain a representative count.
4. With another weighed sample from the same lawn cutting, dry the grass in an oven overnight.
5. Ash the same in an evaporating dish on a pipestem triangle. Drop in the dried grass, a little at a time, to avoid excessive smoking and charring. Ashing of the sample is complete when no black char remains in the dish, only a gray ash.
6. Wash down the evaporating dish with a few drops of 1 *N* HCl or 1 *N* HNO_3 and a small quantity of distilled water.
7. Transfer this slurry to the planchet by means of a rubber policeman.
8. Evaporate the slurry to dryness on the planchet by means of a drying oven or infrared lamps.
9. Count the samples obtained over a period of time until no activity can be accurately detected.
10. Record all results as counts per minute per gram.

Counting

Due to natural activity and cosmic radiation, there is a small number of "counts" which are recorded by the counting device. This is known as "background" which must be determined and allowance made each time counting is done. Three things are also important in performing quantitative counting of radioactive material. These are known as the geometry, back-scatter, and self-absorption. Geometry is the relative distance between the sample and the counting window of the G-M tube. If this distance is varied to any measurable extent, the counts per minute recorded will also vary, since radiation will vary inversely as the square of the distance.

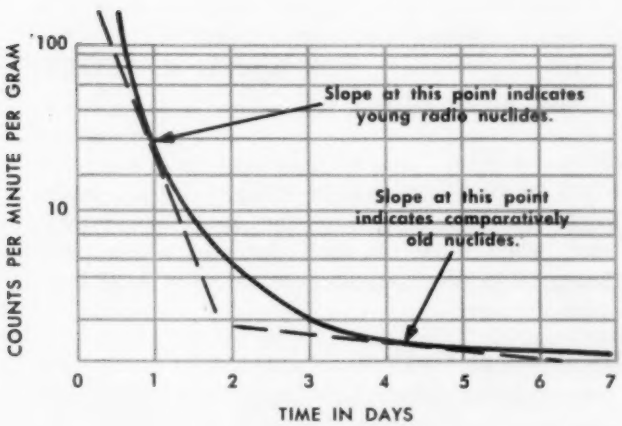
Back-scatter is the term applied to the reflection of radiation. Different surfaces will reflect radia-

tion in varying degrees. If a planchet is counted resting on an iron surface and then subsequently counted when resting on a ceramic surface, the counts recorded will vary. Self-absorption occurs when the sample in the planchet is so thick that some radiation is absorbed by the sample before it has a chance to reach the counting tube. This, of course, lowers the recorded amount of activity of a sample and consequently gives incorrect information. It is therefore important that the planchet be kept an equal distance from the counting window of the G-M tube; that the planchet rests on the same surface during the counting operation; and that the sample never be too thick.

After a few weeks, the activity of the sample will have decayed to the point that it is no longer detectable. If counting proceeds to this point, sufficient data will have been collected so that the data may be plotted on semi-log paper. Usually counts are plotted as the log function on this paper while time is plotted as the natural function.

Plotting the Data

1. Obtain semi-log graph paper.
2. Plot the counts per minute per gram vs. the time in days. The counts per minute per gram are plotted on the log scale. The time in days is plotted on the natural scale.



Reading the Graph

The slope of curve will give some indication of the age of the mixed nuclides present. If the slope is near the vertical, the mixed nuclides are comparatively young. If the slope is almost horizontal, the nuclides are usually quite old. This is true since nuclides of a short half-life decay at a rapid rate while those of a comparatively long half-life retain their relative amount of activity over a greater length of time. The accompanying graph indicates how a group of mixed nuclides would look if plotting were begun when their activity was quite young and plotted for an extended period of time.

Suggestions for Further Study

If this work is carried on over a period of time, correlations can be worked out between nuclear testing, rainout and snowout, uptake of radioactivity in the soil, and the uptake by vegetation. For those who are interested, it may be possible to show the increase in radiation of surface and well water with increase in rainout or snowout.

References for "Analysis of Radioactivity in Vegetation" and "Rainout Studies and Techniques."

Teacher

A. S. Goldin, J. S. Nader, and L. R. Setter, "The Detectability of Low-Level Radioactivity in Water." Journal, *American Water Works Association*, Vol. 45, pp. 73-80, January 1953.

L. R. Setter and A. S. Goldin, "Radioactive Fallout in Surface Waters." *Industrial and Engineering Chemistry*, Vol. 48, p. 251, February 1956.

L. R. Setter, A. S. Goldin, and John S. Nader, "Radioactivity Assay of Water and Industrial Wastes with Internal Proportional Counter." *Analytical Chemistry*, Vol. 26, p. 1304, August 1954.

Pupil

Eastman Kodak Company, *Kodak Photographic Materials and Light Filters for the Laboratory.*

John C. Hogg, Otis E. Alley, and Charles L. Bickel, *Chemistry: A Course for High Schools.* D. Van Nostrand Company, Inc., 1957.

Schenberg, Samuel, *Laboratory Experiments with Radioisotopes,* United States Atomic Energy Commission, August 1953.

United States Atomic Energy Commission, *Radiation Safety and Major Activities in the Atomic Energy Programs,* July-December 1956.

University of the State of New York Press, *Living With the Atom.*

A Teacher-Pupil Activity for Senior High Science Grades 11-12

RAINOUT STUDIES AND TECHNIQUES

By T. HANDLEY DIEHL
Cincinnati, Ohio, Public Schools

and L. R. SETTER
Senior Scientist, Robert A. Taft Sanitary Engineering Center

Background

Some excellent work in the analysis of problems of air and water pollution is being carried out at the Robert A. Taft Sanitary Engineering Center. Among the tasks is the problem of radioactive fallout resulting from nuclear bomb tests. Considerable work has been done at the Center on this particular type of pollution. Rainout and snowout are the terms now given to radioactive pollution when applied to rain or snow respectively.

From experience it was found that 250-ml samples of rain or snow were much easier to handle. These samples were collected in glass or plastic containers so that cleaning the vessel to rid it of activity was a minor problem. Both rain and snow samples contain a small fraction of insoluble particles which have a different decay rate from those which are soluble. The insoluble particles are filtered out and are counted separately in this technique. The filter paper used in the filtration has low ash content and extremely small pores. The idea of filtration is to simulate the respiratory conditions of man. It is thought that those particles which are large enough to be retained on filter paper would be those caught in the upper respiratory tract, while those of small diameter which pass through the filter would penetrate the lung and cause damage.

Statement of Problem

To study the activity of rainwater and understand some of the methods employed in this study.

Equipment

A. A scaler or count-rate meter with an end-window G-M tube (a side-window tube will work, but some of the activity will be absorbed by the aluminum window)
B. Planchets (bottle caps from soft drinks may be substituted if the cork is removed from the metal cap)
C. Whatman #42 filter paper
D. Funnel (Büchner or conventional)
E. Crucible
F. Pipestem triangle

This carbon filter extraction process removes substances from water for study of their taste and odor characteristics. F. M. Middleton, left, Sanitary Engineering Center chemist, explains the procedure to T. Handley Diehl, a chemistry teacher at Cincinnati's Central High School, coauthor of this article.

G. Bunsen burner
H. Glass or plastic vessel (large enough to collect at least one 250-ml sample)
I. Rubber policeman

Procedure

1. Collect the rain or snow for counting in a glass or plastic vessel.
2. Divide the rain or snow thus collected into 250-ml samples.
3. Filter each 250-ml sample, using #42 Whatman paper.
4. After the last of a 250-ml sample has been filtered, wash the filter with distilled water to make certain all the soluble radioactive particles are contained in the soluble fraction.
5. Keep the filter paper for ashing.
6. Evaporate the filtrate to dryness in a drying oven or by means of an infrared lamp. (These methods are suggested to avoid spattering the sample.)
7. Wash the vessel which contains the dry filtrate with a small quantity (2 or 3 drops) of 1 *N* HCl or 1 *N* HNO_3 and then distilled water.
8. Transfer this to a planchet or bottle cap and evaporate to dryness again before counting; then count the filtrate.
9. Ash the filter paper from step #5 by folding in the edges of the paper and placing in a crucible on a pipestem triangle.
10. Heat the crucible slowly to a dull red heat (about 600° C). Keep the flame under the crucible until no black char remains from the paper.
11. Wash out the crucible with distilled water and 1 *N* HNO_3 or 1 *N* HCl.
12. Transfer this slurry with the aid of a rubber policeman to an aluminum planchet or bottle cap.
13. Evaporate the slurry to dryness and count with the counter available.

Counting

The counting procedure for this demonstration is the same as that given for the demonstration in the accompanying article, "Analysis of Radioactivity in Vegetation." See page 78.

Suggestions for Further Study

The Taft Sanitary Engineering Center has shown that only about four per cent of the rain activity was found in pond water. It would be possible to make a similar check of pond water simultaneously with the rain tests. In this way checks could be made to see how close the four per cent will correlate with data in the student's own community.

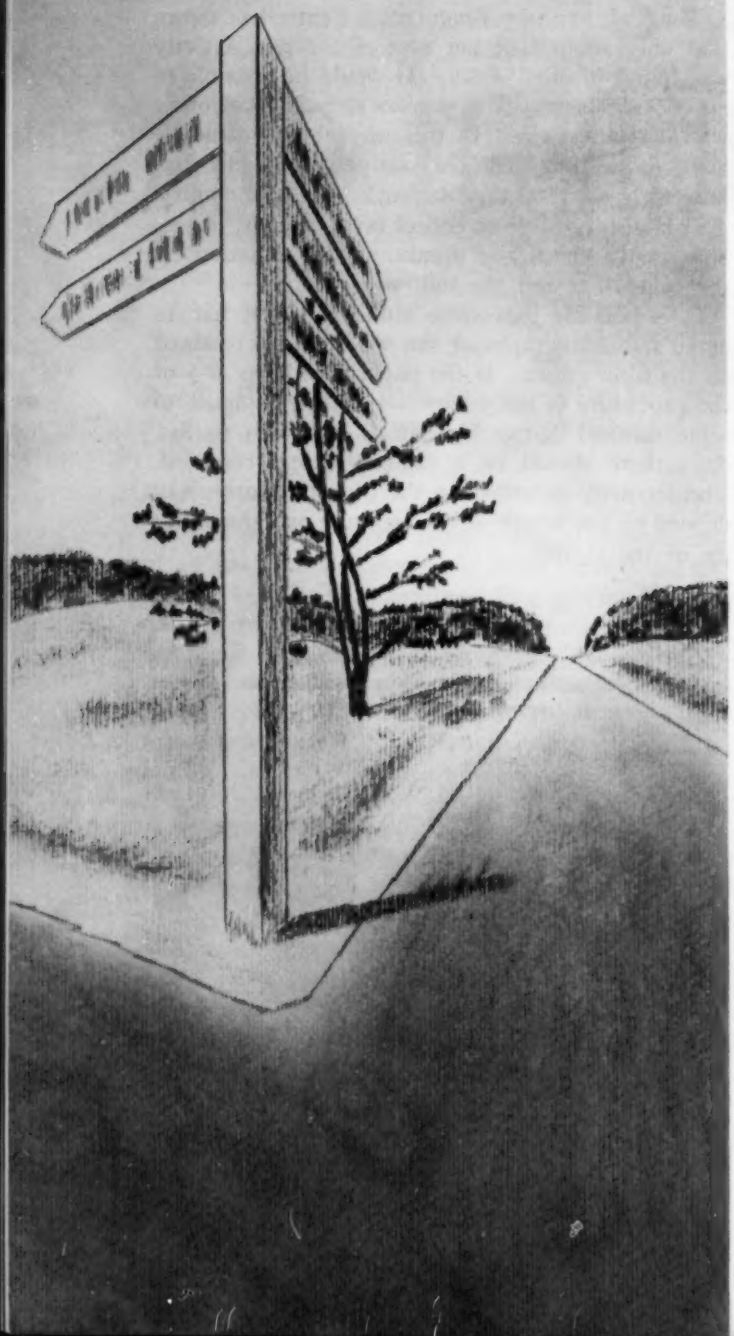
It is also possible to collect lawn rakings, leaves, and soil to check the uptake of the radiation by the vegetation and the soil.

It is possible that some students would like to make radioautographs of the solid sample retained on the filter paper. If the paper from step #5 of the procedure is not ashed but placed adjacent to some medical X-ray film, in about three to five days there should be a radioautograph recorded. The intensity recorded on the film, of course, will depend on the length of the exposure and the activity of the sample.

References (See page 79.)

Teacher Diehl looks on as student Tucker filters a sample of rain water to collect any radioactive material that may be trapped by the filter paper.

GUIDEPOSTS IN SCIENCE EDUCATION



A Report on a Survey of Trends at the Elementary and Secondary Levels

By SAM S. BLANC

Coordinator of Instruction, Gove Junior High School, Denver

AS part of a background study needed to guide the thinking of the K-12 Science Committee in the Denver public schools, the trends in science education at the elementary and secondary levels in schools throughout the country were investigated. One phase of this investigation was a survey of the literature published during the last 20 years. Although the number of studies in science education were quite small in relation to the work in other curricular areas, a number of significant studies were found. These were grouped into three categories: topics that are taught, grade placement of principles and topics, and general trends in research.

Science Topics That Are Taught

In a study to determine the subject matter content in science for grades four through 12, Bruner (3*) analyzed selected courses of study published in 1930-1940. His conclusions indicate that although most courses of study have been

* Figures in parentheses refer to bibliography at end of article.

worked out by a deductive process, principles of organization and criteria for selection of materials of instruction have not been formulated. However, he does state that although there was no agreement as to sequence of material from grade to grade or within the grade level, makers of courses of study seem to be conscious of the needs and interests of students in science. One problem pointed out is that science education should deal with what should be included in a course of study to keep children scientific, rather than to make them scientific.

Gilbert (6) made a survey of 30 courses of study in elementary science with the purpose of determining the topics that are presented and the levels at which they appear. Again, little agreement was found with respect to the kinds of topics presented and their grade placement.

In a recent doctoral study, Dubins (4) analyzed 163 courses of study in elementary science to determine the content with respect to subject matter by topics and grade level, and science principles presented by grade level. He found that a total of 476 major topics appeared in the guides. Of these, less than four per cent recurred in over half of the 163 courses of study. He indicates that there was evidence concerning grade placement of several major topics, since 36 of these had a greater occurrence in one grade than in others, and 20 recurred in two or three grades. He concludes, however, that with only 56 of the 476 major topics identified having any indication of uniform grade placement, the lack of repetition is proof of the doubt and confusion which exist as to what principles should be taught in elementary school science.

Flannigan (5) analyzed 117 returns of a questionnaire sent to 800 public high schools selected at random. His study indicates that general science (physical science, consumer science, etc.) courses, especially those offered to replace the conventional courses in physics and chemistry, are increasing in number. The great majority of these courses are being offered at the junior and senior years. This would indicate that most schools are fairly well satisfied with ninth-grade general science and tenth-grade biology as now offered. No general agreement was indicated as to specific topics to be included in general science courses, due in part to differences in environment, type of student served, and geographical location.

Studying the shortage of scientifically prepared manpower in industry, medical research, and defense of the country, Skilken (14) proposes to meet the problem by a unified approach to science study, aimed at reducing the amount of duplication in courses and providing for more time in the school program to present science. He believes that pure science springs from individuals who are capable of taking "general and unprescribed views of nature" and that students should be able to relate their science learnings to their living.

Surveys of curricula do little more than identify practices among which are found both desirable and undesirable elements. In an effort to determine how current curriculum practices match with the "ideal," Marsh (10) compared the content of 19 courses of study in use since 1945 with the content desired by 35 elementary teachers considered "expert" in science. The conclusion is that these courses of study agree rather well with the preferences of the experts, especially with respect to subject matter. The greatest disagreement is in the general pattern and format of the courses.

Grade Placement of Principles and Topics

The rapid growth in the applications of science principles has tended to push the covers of science textbooks far apart. The attempt to "cover a text" becomes increasingly inadequate. There must be selection in terms of principles and understandings which children need in a modern world. Recently much research has been devoted to trying to assign various topics of science to specific age or grade levels. The aims of these several studies were to determine the levels at which optimal learning of topics may be accomplished.

Smith (16) (15) attempted to determine the relative importance of principles of science which are desirable for inclusion in a general science course at the junior high school level. He also wanted to determine the relative values of experiments which are desirable for inclusion in a general science course at this level. Smith's findings seem

(Continued on page 109)

As is well known to readers of *The Science Teacher*, NSTA's Commission on Education in the Basic Sciences is preparing to undertake a major study in the area of fundamental problems of science teaching. Pending the completion of this study, reasonably good forms of assistance in this area are not too plentiful. *TST*'s editors, therefore, are delighted to have this survey report from Sam S. Blanc. Reprints are available—without charge in reasonable quantities; write to: The National Science Teachers Association, 1201 Sixteenth Street, N.W., Washington 6, D.C.

How to Up-Grade Yo

Sheldon

A Complete Educational Program — Not Just A Table. All Areas of Instruction Are Served, Every Student Has Equal Learning Opportunity, All Apparatus is Stored at Point of Use, All Facilities and Floor Plans Are Educationally Correct

TOTAL EXPERIENCE SCIENCE PROGRAM

Your Science Facilities Now

REMODEL YOUR OLD LABORATORIES INTO A SHELDON "EDUCATIONALLY CORRECT" SCIENCE DEPARTMENT

Make Science More Inviting. Let Sheldon engineers show you how to remodel your present science department so your school can have the advantages of a Sheldon Total Experience Science Department *now*.

This Sheldon program enables the teacher to administer the broadest curriculum of science, including experiments and special projects that generate student interest and enthusiasm so science study and careers are most inviting.

Educationally Correct. The design and arrangement of Sheldon furniture in both the laboratory and lecture area are educationally correct. All apparatus is stored at point of student and instructor use. Traffic is held to a minimum. Every minute of class time can be used productively.

Expert Help Available To You Now. Sheldon engineers are available, without obligation, to review your problems and make recommendations, including schematic drawings and budget estimates. Where feasible they will show you how an additional room, adjoining your present laboratory or located elsewhere, can give you an even more comprehensive department. For full particulars, ask your nearby Sheldon representative, or write the Muskegon office.

Consultation Including Engineering Recommendations Available Without Obligation

E. H. Sheldon EQUIPMENT COMPANY

MUSKEGON, MICHIGAN

SUMMER RESEARCH ASSISTANTSHIPS FOR SCIENCE TEACHERS

The 1958 offerings of summer research assistantships for high school science teachers cover a wide variety of fields, appealing to virtually any interest of the teacher who wants to do summer research. The assistantships are available in colleges, universities, and industrial laboratories. Their benefits are recognizably mutual. In a time when more and more emphasis is being put on the value of research experience to the high school science teacher, the summer assistantships present a working opportunity to gain this experience. At the same time, they provide college level teachers with a better understanding of their high school colleagues' problems.

The following summary of summer research assistantships lists information received at magazine press time. This summary, provided by the Future Scientists of America Foundation of the National Science Teachers Association, is printed here as a professional service.

The listings give the name of the institution offering the program, the name of the person to contact, number of assistantships available, field of research, qualifications and special skills specified, hours, remuneration, and other pertinent data, in that order.

Agricultural and Mechanical College of Texas, College Station, Texas. Dr. J. G. Potter, Physics Department. **One or two** in development of instrumentation in measurements in research in nuclear energy levels induced by irradiation by neutrons in a reactor, and in nuclear magnetic resonance phenomena. Requirements: Some experience in work with instrumentation and electronics circuits; college work in physics and mathematics through differential equations. Minimum of six weeks, preferably 12 weeks, 20 hours weekly or more. $150 per month for 20 hours per week, correspondingly for more time.

The Agricultural and Technical College of North Carolina, Greensboro, North Carolina. Dr. F. A. Williams, Dean of the Graduate School; Dean L. C. Dowdy, School of Education and General Studies. **Two** in biology and general science. Requirements: Holder of B.S. degree, undergraduate record B, teaching certificate in science and/or biology. Specific skills: Laboratory and research techniques in dealing with rodents, etc. Nine weeks, 12 hours per week. $200 to $300.

American Meat Institute Foundation, 939 East 57th Street, Chicago 37, Illinois. B. S. Schweigert, Director of Research and Education. **One** in chemistry, bacteriology, or nutrition. Requirements: B.S. degree or equivalent. Special skills: Dependent on research area selected. Eight to 12 weeks, 37½ hours per week. $60 per week. Housing can be arranged. Research area, length of time, etc. to be worked out on an individual basis with applicant selected.

Appalachian State Teachers College, Boone, North Carolina. Dr. Herbert Wey, Dean of Graduate School. **Four** in botany and zoology. Requirements: B.S. in biology or equivalent. 12 weeks, ten hours per week. $600.

Bowling Green State University, Bowling Green, Ohio. Dr. Jacob Verduin, Biology Department. **One** in aquatic ecology. Requirements: Ability to identify aquatic organisms. Special skills: Operation of *p*H meter, quantitative analysis of O_2, CO_2, and chemical constituents of organisms. Eight to ten weeks, 25 hours weekly. $40 per week. Housing, campus food services, graduate courses available.

Brown University, Providence 12, Rhode Island. R. B. Lindsay, Dean of the Graduate School. **Ten to 12** under a National Science Foundation grant.

Duke University, Durham, North Carolina. Dr. J. H. Saylor, Department of Chemistry. **Three,** one each in electrochemistry, organic chemistry, and polymer chemistry. Requirements: Undergraduate major in chemistry or its equivalent. June 15 to August 15. 40 hours per week. $400. University housing available.

Illinois Institute of Technology, 3300 South Federal Street, Chicago 16, Illinois. Dr. Martin Kilpatrick, Chairman, Department of Chemistry. **One** in applicant's choice of 18 chemistry research projects being carried on by staff members; list available on request. Requirements: B.S. with major in chemistry. Special skills: Interest and aptitude for experimental research. Two months, minimum of 21 hours per week. $450.

Kansas State College, Manhattan, Kansas. Dean Harold Howe, Graduate School. **One** in biochemistry or analytical, inorganic, organic, or physical chemistry. Requirements: Adequate background in chemistry. Special skills: Usual laboratory techniques. June 9 to August 9, 20 hours per week. $320 with B.S., $350 with M.S. May take up to five credits.

Michigan State University, East Lansing, Michigan. Dr. W. B. Drew, Botany Department; Dr. S. K. Haynes, Physics Department. **One or more,** normally filled by graduate students on campus during the summer.

New Mexico Institute of Mining and Technology, Socorro, New Mexico. Arthur P. Stanton. **One** in atmospheric physics, exploration geophysics, ground water, natural radioactivity, or geochemistry. Requirements: Elementary physics and/or chemistry with some laboratory experience. Nine weeks, 40 hours per week. $2 per hour or more depending on qualifications. Dormitory space for single persons.

Polytechnic Institute of Brooklyn, 333 Jay Street, Brooklyn 1, New York. Professor S. V. Nardo. **One or two** in aircraft, missile structural research; supersonic aerodynamics. Requirements: B.S. in engineering or physics, basic knowledge in solid or fluid mechanics, mathematics desirable. Minimum of ten weeks, 40 hours per week. $350 per month or more.

Polytechnic Institute of Brooklyn, Microwave Research Institute, 55 Johnson Street, Brooklyn 1, New York. Jerome Fox, Research Supervisor. **Two** in application of solid state phenomena to microwave problems. Requirements: Modern physics background. Entire summer, 40 hours per week. $400 per month.

Purdue University, Lafayette, Indiana. Professor R. R. Armacost, Coulter Hall. **Two** in physics or chemistry. Eight weeks, 40 hours per week. $600.

Texas College of Arts and Industries, Kingsville, Texas. Ernest H. Poteet, President. **Two** in chemistry and/or physics. Requirements: At least B.S. degree and teaching experience. Special skills: Teaching and assisting in laboratory. Six weeks, 20 to 40 hours per week. $80 to $200 per month. College housing for single person available at $75 to $100 per month; private housing for married individuals at reasonable rate.

Texas Woman's University, University Hill Station, Denton, Texas. Dean Francis W. Emerson, Dean of Admissions, Registrar. **Unspecified number** in chemistry, biology, different areas of both. Requirements: Work beyond a Bachelor's degree or unusual preparation. Length varies with project and candidate. Remuneration to be determined. Housing available.

University of Illinois, Graduate College, 109 Administration East, Urbana, Illinois. Miss Antoinette LaVoie. **Two** in any areas of physical and biological sciences. Requirements: Sufficient background in the science involved to undertake independent research under general supervision. Eight weeks, 20 to 40 hours weekly. $400.

University of Maryland, College Park, Maryland. Professor Howard Laster, Physics Department. **Six** in physics: cosmic rays, elementary particle theory, field theory, fluid dynamics, gaseous electronics, microwave spectroscopy, molecular physics, nuclear physics, solid state, and upper atmosphere physics. Requirements: Bachelor's degree; and research experience and/or advanced training in mathematics (through calculus) and/or special knowledge of electronics desired. Length adjusted to needs of the assistant. $250 to $400 per month for full-time work, depending on experience; part-time work prorated.

University of North Dakota, Grand Forks, North Dakota. J. Donald Henderson, Director of Summer Science Institute. **One** in entomology. Requirements: Undergraduate major in biology. Nine weeks. $300. Dormitory rooms available. Research program and courses to be arranged with assistant.

University of Pittsburgh, Pittsburgh 13, Pennsylvania. Richard H. McCoy, Assistant Dean, Division of the Natural Sciences. **Three** in physics, biophysics, or psychology according to qualifications of applicant. Requirements: At least undergraduate major in the specific field or closely related fields of science. Special skills: Good laboratory techniques. About eight weeks, 20 hours weekly. Approximately $2.50 per hour. Campus housing available.

University of Redlands, Redlands, California. Dr. R. J. Krantz, Dr. Robert Maybury. **Two** as follows: One in preparation and characterization of tertiary nonyl alcohols; this is largely a preparative organic synthesis under direction of Dr. Krantz. Requirements: At least B.S. in chemistry. About eight weeks. $600 for eight weeks. Summer school courses in education and in science available. One under a National Institutes of Health grant for a high school teacher interested in associating with Dr. Maybury in protein physical chemical studies (light-scattering ultracentrifuge, optical rotation, nucleoprotein preparative work). Requirements: Strong chemistry, biology, or physics background; B.S. or M.S. Ten weeks, 40 hours per week. $1000.

University of Rochester, College of Arts and Science, Rochester 20, New York. Professor Edwin O. Wiig, Chairman, Chemistry Department. **Two or three** for high school science teachers with suitable backgrounds in chemistry or chemistry and mathematics.

Wayne State University, Department of Chemistry, Detroit 2, Michigan. Dr. George H. Coleman, Head, Department of Chemistry; Dr. Stanley Kirschner. **Ten** in all divisions of chemistry including analytical, inorganic, organic, physical, and biochemistry. No special requirements or skills other than desire to do research. Eight weeks, full time. $600 basic stipend, tax free for eight weeks; $90 dependent allowance; up to $75 for travel; tuition. Some private, some university housing available. Assistants may take equivalent of a full load of graduate courses if qualified.

GENERAL

Princeton University, Princeton, New Jersey. Samuel C. Howell, Assistant to the Dean of the Faculty. No specific assistantships set up but the university welcomes applications from high school teachers for consideration in view of possibilities which might be available during the summer. The program of sponsored research usually falls largely in the area of engineering with positions for mathematicians, chemists, and physicists arising occasionally. Security clearance required for projects of a classified nature.

University of Wisconsin, Madison 6, Wisconsin. University's Research Committee makes project grants to faculty members involving the employment of research assistants for the summer months only. High school science teachers are encouraged to apply directly to the university's science departments and faculty.

CONVENTION HIGHLIGHTS

GLENN O. BLOUGH. *NSTA President, Associate Professor of Education, University of Maryland, College Park.* Keynote speaker, Wednesday afternoon. Topic: "What Constitutes Effective Science Teaching?"

KENNETH E. OBERHOLTZER. *Superintendent, Denver, Colorado, Public Schools.* Moderator, panel discussion, Thursday morning. Subject: "What Are the Characteristics of a Good Science Teacher?"

CLARK HUBLER. *Wheelock College, Boston, Massachusetts.* Keynote speaker, pre-convention meeting of elementary school science supervisors, Tuesday afternoon. Topic: "Building Science into the Elementary School Curriculum."

ELBERT P. LITTLE. *Executive Director, Physical Science Study Committee, Massachusetts Institute of Technology, Cambridge.* Chairman, Curbstone Clinic 12, Thursday morning and afternoon. Subject: "The Physical Science Study—An Experiment in the Redesign of High School Physics."

RAY H. SULLIVAN. *Group Vice President, Ford Motor Company, Dearborn, Michigan.* Business-industry luncheon speaker, Friday. Topic: "Science Education—Time for Model Change-over?"

ERNST STUHLINGER. *Army Ballistic Missile Agency, U. S. Army Ordnance Corps, Redstone Arsenal, Alabama.* Luncheon speaker, Saturday. Topic: "Space Travel and Science Education."

J. DARRELL BARNARD. *School of Education, New York University, New York City.* Speaker, secondary school teachers group meeting, Friday morning. Subject: "How Can We Improve Classroom Instruction Through Research in Science Teaching?"

PAUL L. DRESSEL. *Director of Evaluation Services, Michigan State University, East Lansing.* Chairman, Curbstone Clinic 17, Thursday morning and afternoon. Subject: "Evaluation of Learning in Science—Instruments, Procedures, and Role of NSTA Committees in This Area."

ROSE LAMMEL. *Professor of Science Education, Wayne State University, Detroit, Michigan.* Speaker, second general session, Wednesday evening: Topic: "What Constitutes an Effective Science Program?"

HOWARD E. WILSON. *Professor of Education, University of California at Los Angeles.* Speaker, fourth general session, Friday morning. Topic: "How Can We Improve Classroom Instruction Through Research in Teaching?"

NSTA 6th Annual National Convention

DENVER

March 26-29

MARGARET MEAD. *Author, Associate Curator of Ethnology, American Museum of Natural History, New York City.* Annual banquet speaker, Thursday evening. Topic: "Bringing Science to Life."

DOROTHY ALFKE. *NSTA Specialist for Elementary Science, Associate Professor of Education, Pennsylvania State University, University Park.* Presiding, pre-convention supervisors luncheon, Tuesday.

KENNETH E. VORDENBERG. *Supervisor of Science, Secondary Schools, Cincinnati, Ohio, Public Schools.* Chairman, Curbstone Clinic 6, Thursday morning and afternoon. Subject: "TV Experiments in Teaching Elementary and Secondary Science."

GEORGE W. FRASIER. *Lecturer in Education, Stanford University, Stanford, California; President Emeritus, Colorado State College, Greeley.* Moderator, panel discussion, Thursday morning. Subject: "What Are the Characteristics of a Good Science Teacher?"

SAM S. BLANC. *Coordinator of Instruction, Gove Junior High School, Denver, Colorado.* Co-Chairman, Convention General Planning Committee.

DONALD G. DECKER. *Chairman, Division of the Sciences; Director of Instruction, Colorado State College, Greeley.* Convention Program Chairman.

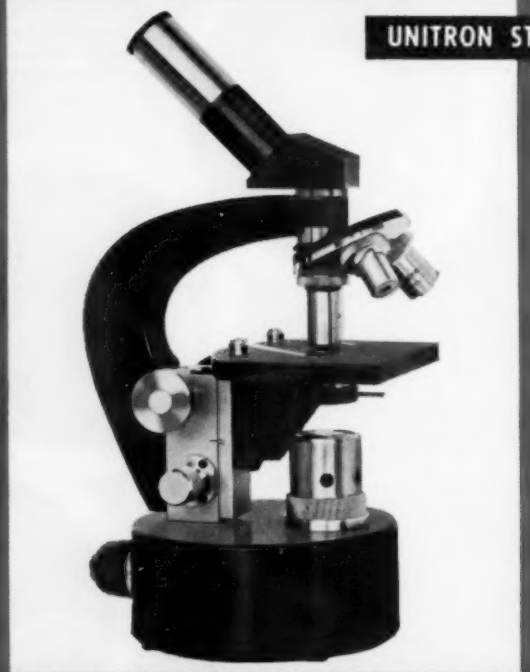
J NED BRYAN. *Director, National Education Association's Academically Talented Pupil Project; on leave of absence, Professor of Science Education, Rutgers University, New Brunswick, New Jersey.* Chairman, Curbstone Clinic 1, Thursday morning and afternoon. Subject: "Teaching the Academically Able Students in Science in Junior and Senior High Schools."

GERALD S. CRAIG. *Professor Emeritus, Teachers College, Columbia University, New York City.* Speaker, elementary school teachers group meeting, Friday morning. Subject: "How Can We Improve Classroom Instruction Through Research in Science Teaching?"

ARTHUR R. OLSON. *Administrative Director, Elementary Education, Denver, Colorado, Public Schools.* Speaker, pre-convention supervisors luncheon, Tuesday. Topic: "Supervising for Program Growth."

PAUL DeH. HURD. *School of Education, Stanford University, Stanford, California.* Speaker, sixth general session, Saturday morning. Topic: "What Constitutes Effective Use of Instructional Materials in Science Teaching?"

UNITRON student microscopes offer



UNITRON STUDENT AUTO-ILLUMINATION MICROSCOPE, MSA

The UNITRON Student Auto-Illumination Microscope, Model MSA, employs a newly designed stand in which all components and controls are within easy reach. The inclined eyepiece tube allows comfortable posture and may be turned in any optional observing direction to permit two students sitting side by side to share a single instrument. With the built-in illuminating system of the superior low-voltage type, each student is assured of the correct lighting. The transformer is conveniently housed in the microscope base itself where it contributes to the stability of the stand rather than to the clutter of the laboratory table.

Model MSA comes complete with triple revolving nosepiece and three objectives: 4X, 10X, 40X; three eyepieces: 5X, 10X, 15X; coarse focusing with safety stop; fine focusing; condenser and iris diaphragm; filter holder and filter; accessory substage mirror; wooden cabinet and dustcover. Mechanical stage available at extra cost.

only $107

UNITRON STUDENT MICROSCOPE, MUS

Despite its low cost, UNITRON Model MUS offers features lacking even in much more costly models usually offered for student use. For example, both fine and coarse focusing are provided — not merely a single focusing control; an iris diaphragm to regulate aperture for highest resolution — not merely a disk diaphragm; and a condenser system for optimum illumination.

The optical performance of Model MUS at each of its magnifications is equivalent to that of expensive research models. All mechanical parts are machined to close tolerances and the stand is beautifully finished in black and chrome. Model MUS comes complete with triple revolving nosepiece and three objectives: 5X, 10X, 40X; choice of two eyepieces from: 5X, 10X, 15X; coarse focusing (accessory safety stop available); condenser with iris diaphragm; inclinable stand; plano-concave mirror; wooden cabinet and dustcover. Mechanical stage available at extra cost.

only $74

unexcelled quality at budget prices

UNITRON DISSECTING ADS

Heavy base, micrometric rack and pinion focusing, arm rests, mirror and background plate, large glass stage plate, Steinheil magnifiers.

ADS: for 10X, 20X **$32.50**

ADSA: for 5X, 10X, 20X **$36.50**

UNITRON PHASE MPEA

The first student phase model ever to be offered. Observe protozoa, plankton, etc. in the living state *without* chemical staining. Objectives: 4X, P10X, P40X. Eyepieces: 8X, 15X. Condenser and phase diaphragm. Write for a reprint of Professor Corrington's article on this remarkable instrument.

MPEA..... $99
(f.o.b. Boston)

UNITRON STEREOSCOPIC MSL

A wide field, binocular, 3-D dissecting model. Diopter and interpupillary adjustments. Removable glass stage plate. One set of eyepieces for 10X, 20X or 30X included; others available at extra cost.

Model MSL..... $110
(f.o.b. Boston)

UNITRON PHOTOMICROGRAPHY SET

Duplicates the performance of costly apparatus. Fits any standard microscope. Mounting brackets adjust for your camera. Viewing telescope allows focusing and selection of field while the camera is in position.

Model ACA... $39.95

UNITRON LABORATORY MLEB

Uses the same large, heavy stand as our research models. Three objectives: 4X, 10X, 40X; three eyepieces: 5X, 10X, 15X. Coarse and fine focusing. Condenser and iris diaphragm. Filter holder and filter. Mechanical stage available.

MLEB..... $118

ACCEPT A FREE 10 DAY TRIAL

We invite you to try any UNITRON Microscope in your own classroom for 10 days at absolutely no cost or obligation. Let our instruments prove their value and quality to you, *before* you decide to purchase. You will see for yourself why UNITRON is the choice of America's leading universities, schools, and industrial laboratories.

THIS COMPLETE CATALOG ON UNITRON MICROSCOPES IS YOURS FOR THE ASKING!

Gives complete information on the UNITRON Models described above as well as on many others for all types of microscopy. You will find this informative publication a valuable addition to your files.

QUANTITY DISCOUNTS AVAILABLE ON ALL MODELS

Prices include wooden cabinet, plastic dustcover, and free delivery to your school unless otherwise noted.

UNITRON
INSTRUMENT DIVISION OF UNITED SCIENTIFIC CO.
204-206 Milk Street • Boston 9, Mass.

Please send me your complete catalog on UNITRON Microscopes.

Name and Title_____

School or College_____

Address_____

City_____ State_____

Classroom Ideas

Biology

Paraffin Models

By MARIE G. BARNES, Sidney Lanier High School, Montgomery, Alabama

This report was an entry in the 1956-57 STAR (Science Teacher Achievement Recognition) awards program.

Making paraffin models is one effective way in which students can develop the original, related project which is generally required of each after the class has completed work on a given unit in biology.

Made by the method described, this paraffin model of the interior section of the human heart was a science fair winner. Less than 25¢ was spent on materials used in the model. The key is: 1—Aorta. 2—Pulmonary artery. 3—Pulmonary veins. 4—Left atrium. 5—Mitral valve. 6—Left ventricle. 7—Heart muscle. 8—Portion of blood vessels that nourish heart muscle. 9—Right ventricle. 10—Tricuspid valve. 11—Right atrium. 12—Inferior vena cava. 13—Pulmonic valve. 14—Aortic valve. 15—Superior vena cava.

The pupils are furnished paraffin and colored crayons. (I believe this technique is original). When paraffin is placed in the separate sections of a muffin pan, over very low heat, and the desired color and amount of crayon is put in each of the separate sections, the two blend perfectly. This enables the operator to have several colors in use simultaneously. When the mixture begins to cool, the material can be molded in the hands and it is very easily shaped as desired. Should it harden before completion, a touch with a warm piece of metal or glass will keep it pliable enough to be worked.

This is a splendid way to teach proportions and for pupils to learn details in life cycles of animals and to understand the processes of digestion, respiration, etc.

General Science

Some Materials That Help Get The Idea Across

By LEONA K. ADLER, Hunter College High School, New York City

This article was an entry in the 1956-57 STAR (Science Teacher Achievement Recognition) awards program.

1. Leek leaves. I use leek leaves and lemon leaves to teach leaf structure. Leek leaves are inexpensive and excellent for showing leaf tissues. The students can very easily tear off both upper and lower epidermis by snapping the leaf first one way and then another. The transparency and waxiness of the upper and lower epidermis are then very obvious. The thick mesophyll layer in the leek is a rich green in contrast. Veins can be easily seen within this layer. Students compare leek and lemon leaves as examples of monocotyledonous and dicotyledonous leaves. Leek epidermis is also excellent for microscopic study.

2. Empty vitamin bottles. I have a collection of empty vitamin bottles which I use for a lesson in consumer education when vitamins are being stud-

BELL TELEPHONE LABORATORIES DEVELOPS NEW COMPACT COMPUTER FOR U. S. AIR FORCE

J. A. Githens, B.S. in E.E., Drexel Institute of Technology, and J. A. Baird, Ph.D. in E.E., Texas A. & M., check the control panel of Leprechaun, a new high-speed computer which solves extremely complex problems in one-tenth of a second. Small size and low power are made possible by new design principles and Bell Laboratories' invention of the transistor.

The United States Air Force assigned Bell Labs an interesting assignment: develop a new kind of electronic computer. The major requirement was greater simplicity. Of course, no computer is simple, but this one (known as "Leprechaun" to its designers) is much smaller and simpler than most of the computers currently in use.

It has only some 9000 electrical components; 5000 of them are transistors. As a result, Leprechaun utilizes less than one-third of the components required in conventional computers. This facilitates testing, experimentation, assembly and service.

Even in its experimental state, Leprechaun is a stimulating example of great strides in the simplification and miniaturization of circuitry . . . a problem of deep interest to Labs researchers as they develop radically new equipment for your future telephone service.

BELL TELEPHONE LABORATORIES

WORLD CENTER OF COMMUNICATIONS RESEARCH AND DEVELOPMENT

RIDER BASIC TEXTS FOR MORE EFFECTIVE INSTRUCTION OF ELECTRICITY—ELECTRONICS—TV

"BASIC ELECTRICITY" "BASIC ELECTRONICS"

by Van Valkenburgh, Nooger, & Neville, Inc.

THE FABULOUS "PICTURE BOOK" COURSES DERIVED FROM THE NAVY'S TRAINING PROGRAM!

This is the fabulous "Common-Core" training course so successfully used by the United States Navy! Over 25,000 Navy trainees have already mastered the basics of electricity and electronics this new "learn by pictures" way and now, for the first time, this same material is available to civilian schools! Over 1,700 big "show-how" drawings make every phase picture clear—these illustrations actually make up more than half the entire course!

Here's how these picture courses work: every page covers one complete idea, and there's at least one big drawing on that same page to illustrate and explain the topic covered. "Demonstrations", plus review pages at the end of every section, highlight the important points just covered. Written in clear, everyday English, they present basic electricity and electronics as they've never been presented before!

Vols. 1 and 2 of *"Basic Electricity"* cover DC components and circuits; Volumes 3 and 4 cover AC components and circuits; Volume 5 covers AC and DC motors and machinery.

Volume 1 of *"Basic Electronics"* covers Diodes & Power Supplies; Vols. 2 and 3 cover Amplifiers & Oscillators; Vols. 4 and 5 cover Transmitters & Receivers.

PAPER EDITION—5 volumes. Total cost for *either* the 5-vol. *"Basic Electricity"* or 5-vol. *"Basic Electronics"* series $10.00. CLOTH EDITION—all 5 volumes bound in a single volume. *"Basic Electricity"* . . . *"Basic Electronics."* $11.50 each.

—and now a new course in BASIC TELEVISION by Dr. Alexander Schure

A 5-volume "picture-book" course teaching the elementary principles and practices of black and white television easily, quickly and understandably. Every page covers one complete idea, and there's at least one big illustration on that same page to explain it. Each volume covers a specific number of sections in the receiver. The presentation is like a spiral—first an overall view of the whole, and then a detailed explanation of each part; perfect for maximum understanding.

#198 soft cover, 5 vols., 6 x 9", per set $10.00
#198-H cloth bound, all 5 vols. in one binding, $11.50

ORDER YOUR REVIEW COPIES TODAY!

School Discounts Apply

JOHN F. RIDER PUBLISHER, Inc.
116 West 14th St., New York 11, N. Y.

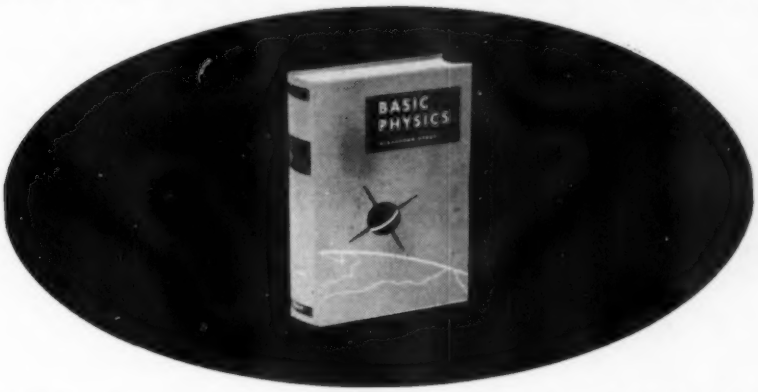
ied. Students are asked to study the labels and see what the labels tell them. It is soon brought out that vitamin pills vary greatly in content and that the price is indicative only as it is related to the content of the pills, the number of pills in the bottle, and the particular needs of the patient. Questions which can be considered include the meaning of Int. U., U.S.P. Units, control number, and the various measurements given.

3. Vitamin pills and capsules. Cut open some vitamin capsules on unglazed paper. Fat-soluble vitamins are often prepared in a fatty solvent. Hold a vitamin A capsule up to the light and note the amber color. Cut the capsule open and watch its golden contents pour out. Showing the actual vitamin pills conveys the idea that vitamins are definite chemical substances, which you can see, hold, and feel like any other substance.

4. A transparent, rectangular, plastic icebox dish. It is used to teach cell structure. After my students have made firsthand microscopic observations of cells and pooled their observations, I clinch the three-dimensional concept of cells by using a model of a plant cell. A transparent icebox dish with a cover is completely filled with gelatin. I use twice the recommended amount, so that the gelatin does not turn out too soft. I make a "nucleus" that is round and about twice as thick as the "cytoplasm" and I embed the nucleus in the cytoplasm when the latter is just beginning to jell. Seedless grapes can be added for chloroplasts and holes can later be dug out with a spoon and filled with water in class, to represent vacuoles. It can be brought out that animal cells differ in that they are not enclosed in a plastic dish, i.e., a cell wall of cellulose.

5. A funnel, filter paper, copper sulfate solution, and powdered carbon. I use these to demonstrate the formation of urine, comparing the filtration process to the filtration in the nephrons of the kidney. After explaining that blood maintains exact chemical composition regardless of how much water is drunk, salt ingested, and so forth, I ask how this is possible. I then mix carbon particles with copper sulfate solution and stir up the resultant suspension. I ask how the carbon and copper sulfate can be separated. I then filter this mixture and while the filtrate is slowly dripping through, I draw a diagram of the apparatus on the board, labeling funnel, filter paper, tube, substance to be filtered, and filtrate. Next to it, I draw a diagram of a nephron, showing the glomerulus, Bowman's capsule, and the collecting tubule and I add droplets of urine to the collecting tubule. The label lines used for the filtration diagram are then extended to the nephron diagram to show the corresponding action. Substance

MORE EFFECTIVE INSTRUCTION OF PHYSICS AND MATHEMATICS WITH THESE NEW RIDER TEXTS



A dramatic advance in the teaching of physics

BASIC PHYSICS by Dr. Alexander Efron, Stuyvesant High School, New York City

At last, the very physics text that you have always wanted, the one that you have always felt the need for . . . the one that means more effective instruction, better students.

Written by Dr. Alexander Efron, dedicated educator with more than 25 years of teaching experience, Basic Physics is a new, thoroughly modern text with a new teaching approach offering an enriched course in intermediate physics for high school and junior college students. Designed to make instruction more effective, and at the same time, motivate student interest, Basic Physics is comprehensive, up-to-the-minute, technically accurate and is supported by carefully prepared detailed illustrations that enhance the text.

These thoroughly readable text books comprise a psychologically organized course in intermediate physics using the "spiral" approach. Volume 1 offers an overall view of most of the simpler material of the standard course. Volume 2 covers more difficult topics as well as a "deeper" and a more analytical look at those topics which have been previously presented in a purely descriptive and empirical fashion. This two volume work (single binding) constitutes an integrated year's course, the study of which fully satisfies the requirements of the college board as well as all local, regional and state sylibi.

In addition to the classical subjects, these are some of the vital, modern, up-to-the-minute subjects comprehensively covered in Efron's Basic Physics . . . does your present text cover them?

● *Heat: a form of energy in transit* ● *Levels or "hills" of energy* ● *Transport of heat; heat "carriers"* ● *Penetration of the ionosphere* ● *Physical vs psychophysical sound* ● *Hearing, speech and music* ● *New Permanent magnets* ● *Ferroelectrics* ● *Magnetic domains* ● *Ultrasonics* ● *Oxidation-reduction in electric cells* ● *History of sub-atomic particles* ● *Reflection and refraction; Huyghenian approach* ● *Terminology of illumination* ● *Schematics of heat engines* ● *Electric current: non-"hydraulic" approach*

Released in September, Basic Physics has achieved immediate adoptions in schools with the highest standards of physics instruction. #195, 2 volumes in single cloth binding, 724 pp., 800 illustrations, $7.60 list.

FREE

Informative 16-page booklet "You Can Make the Teaching of Physics Exciting" by Dr. Alexander Efron explains and tells how to utilize the *"spiral" approach* of teaching to create better student understanding and interest. It's yours free, simply use convenient coupon.

Physics, Mathematics and their Relation to Electronic Communications Made Crystal-Clear in these Brilliant Works—written at the college level.

PHYSICS AND MATHEMATICS IN ELECTRICAL COMMUNICATION by James Owen Perinne, Ph.D.

This is a profound and probing explanation of what happens in electrical circuits that contain resistance, inductance and capacitance. While it is a penetrating analysis, it is presented in an unusually lucid manner. The author demonstrates a talent for selecting that avenue of approach in analysis which leads to utmost clarity. The text contains numerous explanatory diagrams, many conceived by the author, that point out and simplify concepts that normally are considered complicated. Each graph, complete with point-by-point identifying nomenclature, illuminates the text. On a foundation of associated mathematics made completely understandable and replete with numerical examples, the author brilliantly ties together physical concepts and electrical communication. An entirely new approach is used in analyzing hyperbolic functions, expoential equations and related functions. Of special significance is the content of the graphical demonstrations of electrical behavior.

Here's what the leading educators and businessmen are saying about Perinne's new work—Associate Dean E. B. Stavely of the Pennsylvania State University, College of Engineering and Architecture, ". . . a job of monumental proportions." Professor Arthur R. Albert, School of Engineering, Oregon State College, ". . . I found your writings of interest and value and I send my congratulations." Dwight D. Phelps, Assistant Vice President, Mountain States Telephone and Telegraph Company, "I have found your presentation completely up to the high standards you have always set in making difficult subjects exciting and seemingly simple." #219, 8½ x 11", Cloth Bound, $7.50.

UNDERSTANDING EXPONENTIALS & HYPERBOLIC FUNCTIONS by James Owen Perrine, Ph.D.

This text marks a very progressive departure from the conventional presentation of these subjects. Using an entirely new approach in analyzing hyperbolic areas and functions, the text conveys in an unusually lucid manner the fundamentals and derivation of many mathematical subjects. The study of the laws of geometric retrogression will prove invaluable in understanding expoential equations and related functions. The text is accompanied by numerous explanatory diagrams which point out and simplify many of the concepts which are normally considered complicated. Written for college students and all others interested in mathematics. #220, Soft Cover about 115 pp., 8½ x 11", illus. $2.90.

Order your review copies today. School discounts apply.

John F. Rider Publisher, Inc. **ST-3**
116 West 14th Street, New York 11, N. Y.

Please rush review copies of following:

.....Basic Physics
.....Physics and Mathematics in Electrical Communications
.....Understanding Expoentials and Hyperbolic Functions
.....Please send free booklet "You Can Make the Teaching of Physics Exciting"

School ..... Position .....
Name .....
Address .....
City ..... Zone ..... State .....

Just published!

SCIENCE FOR THE ELEMENTARY-SCHOOL TEACHER NEW EDITION

By GERALD S. CRAIG

The New Edition of this widely used book combines method and content; and provides an up-to-date course in teaching elementary science. It is designed for use in teachers' colleges, in professionalized content courses in science, in workshops, and in study groups. It is also a book for the classroom teacher to keep on her desk where it can serve as a continuous source of information.

Included are a discussion of science teaching from a developmental point of view, many suggested experiences and experiments, and an unusually complete bibliography.

For more information send for complete descriptive circular #51.

GINN AND COMPANY

Home Office: Boston

Sales Offices: New York 11 Chicago 6 Atlanta 3
Dallas 1 Columbus 16 Palo Alto Toronto 7

A NATIONAL SERVICE

ALBERT TEACHERS AGENCY and COLLEGE BUREAU

Efficient, reliable and personalized service for teachers and schools. Under direct Albert management for three generations.

Original Albert Since 1885

Member NATA

37 S. WABASH AVE., CHICAGO 3, ILL.

to be filtered—blood. Filter paper—Bowman's capsule. Tube—collecting tubule. Filtrate—urine.

6. Lead acetate paper and litmus paper. In order to demonstrate what elements are present in protein, burn some protein in a dry test tube. Drape a piece of moistened litmus paper over one side of the rim, a piece of filter paper moistened in lead acetate solution over the other side of the rim. As the protein burns, it blackens, of course, giving the usual clue to carbon. The litmus paper turns blue, because ammonia (NH_3) is released and the lead acetate paper turns black because of the formation of lead sulfide. (Sulfur is present in most proteins.) A little water vapor appears on the sides of the test tube.

7. Clotted blood and oxalated or citrated blood. These may be obtained at medical diagnostic laboratories, if the laboratories are alerted a day in advance to save a sample of blood for you. Use them to show the difference between plasma and cells, the difference between plasma and serum, and what a clot looks like. Explain that oxalate or citrate combines with calcium and thereby keeps the blood from clotting. In other words, by showing these two samples you can show that calcium plays a part in the clotting of blood.

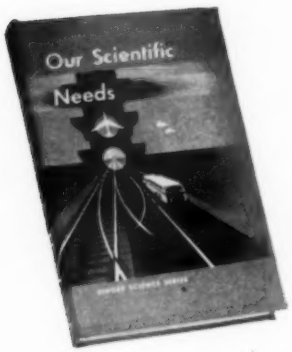
8. Capillary tubes. Capillary tubes can be prepared by heating ordinary glass tubing until it becomes pliable at the point which is over the flame. At this point, take it quickly out of the flame and draw your two hands apart about 20 inches, with a quick pull. The capillary tube formed can be broken into four- or five-inch lengths. I use these mainly for two purposes. One is clotting of blood. Draw a drop of blood into the capillary tube. Wait about three minutes. Break the tube very carefully and slowly pull the broken ends apart. A thread is formed. I also use capillary tubes to illustrate the possible role of capillarity in the rise of water in plants. I use a red colored solution for this so that the students can see it go up.

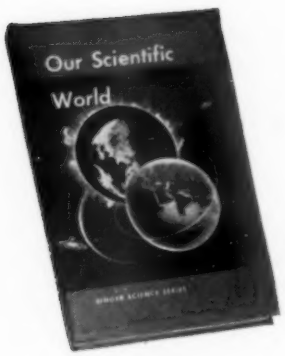
Hundreds of teachers are cheered, thousands of students enthuse because their science texts are from the modern

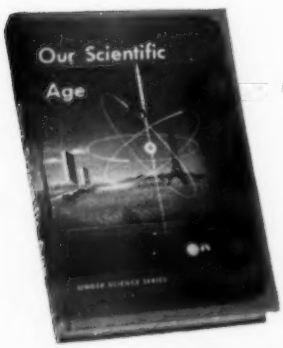
SINGER SCIENCE SERIES

FOR JUNIOR HIGH SCHOOLS – GRADES 7-9

BY FRASIER, MacCRACKEN, DECKER, AND McNAUGHTON







Scientific principles unfold naturally through subject matter and activities closely related to the students' daily experiences. Up-to-date topics such as the man-made satellite and peaceful uses of atomic energy are included. An easy style talks directly to the reader. Explanations *make sense;* the student *learns* something of immediate value to him; he can *keep* and *add to* the knowledge gained as he proceeds to the next level.

These features help make the teaching and learning of science easier:

- text by text spiral-like development of subject matter from each of the five general areas of science: living things, the human body, earth, universe, matter-energy
- labeled experiments in every grade make lessons "stick"
- realistic activities – equipment mostly obtainable in the local community
- a multitude of dynamic illustrations showing scientific phenomena precisely the way the student would see them (on the same page with text matter they support)

Write for further information about the modern texts in the SINGER SCIENCE SERIES for Junior High Schools. (We suggest Booklet 55.) Book for book, they teach more science *than any other series.*

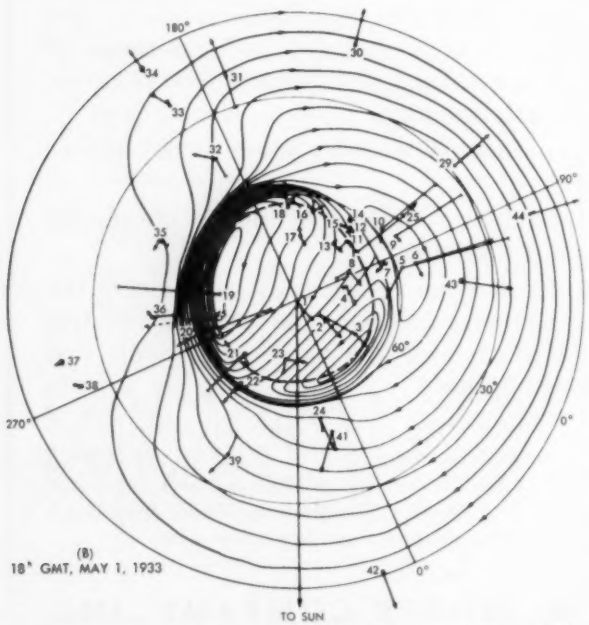
THE L. W. SINGER COMPANY, INC.
249-259 W. Erie Boulevard, Dept. 1, Syracuse 2, N. Y.

SHAPLEY . . . from page 71

More recently, spectroscopic analysis, particularly of very high altitude light-emitting phenomena such as the aurora, has taught us much more about the composition of the upper atmosphere; and, in the past 50 years, study of the behavior of radio waves has contributed to an amazing store of general knowledge about upper atmosphere structure, electrical and magnetic characteristics, density, pressure, temperature, and motions.

Sea level atmosphere consists mainly of nitrogen and oxygen. Nitrogen makes up about 78 per cent of its volume and oxygen slightly less than 21 per cent. The rare gas argon comprises a little less than one per cent, and carbon dioxide, the fourth most common constituent, comprises only .03 per cent. The remaining .01 per cent is shared by the rare gases neon, helium, krypton, xenon, ozone, and radon.

The components of the lower atmosphere are relatively uniformly mixed. A recent IGY rocket experiment using a mass spectrometer, however, seems to confirm the theory that gravity induces a diffusive separation of the constituent gases in the upper atmosphere, causing them to align themselves according to weight. Heavier gases settle and lighter gases move to the outer regions. Moreover, since the major components, oxygen and nitrogen, are believed to change chemically in the upper atmosphere, from the molecular forms (O_2 and N_2) to the triatomic and monatomic forms (O_3 and O, N), their comparative abundance may vary.



AFTER E. H. VESTINE, CARNEGIE INSTITUTE OF WASHINGTON

Calculated ionospheric electric currents for the north polar region during magnetic storm of May 1, 1933, at 1800 GMT, showing one of the three great upper atmosphere electric currents.

Although atmospheric constituents undergo chemical alteration and new materials are constantly brought in by meteoritic, solar, and cosmic particles, spectroscopic study of the highest auroras indicates that the percentage of oxygen and nitrogen remains high up to altitudes of about 700 miles.

A layer of ozone (O_3) exists in the upper stratosphere between altitudes of approximately 15 and 22 miles. This thin layer, the ozonosphere, is formed by conversion of molecular oxygen to ozone through the action of ultraviolet radiation from the sun. Its importance to man is considerable, as much harmful radiation is absorbed in this process.

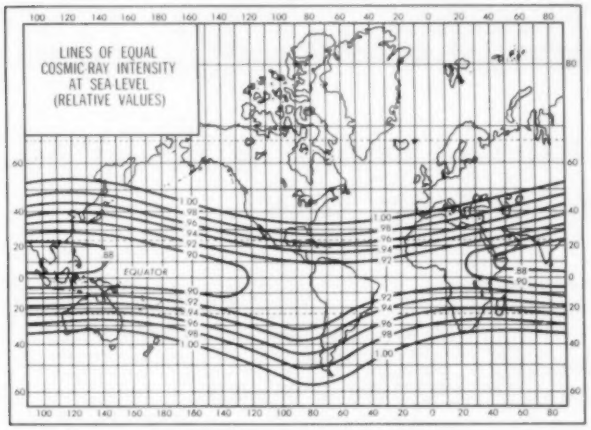
Atmospheric temperatures vary greatly, reversing themselves several times between the surface and the outer margins. Temperatures decrease to about —70° F or —80° F at the top of the troposphere, rise again to about 30° F in the ozonosphere, and drop once again, to —100° F or lower, at the base of the upper atmosphere. Upward from this level there is a continual rise to about 550° F at a height of 100 miles, as much as 1500° F at 250 miles, and possibly considerably greater than 2000° F at the outer fringe of the exosphere.

One estimate, based on calculation of the temperature required to impart to helium and hydrogen, virtually lacking in the outer atmosphere, sufficiently great velocities to permit them to escape from the earth's gravity field, gives a minimum temperature of 2700° F for this outer fringe. These extreme temperatures will go virtually unnoticed by artificial earth satellites and other manmade space vehicles, however, as the distances between the superheated particles comprising the upper air, actually billions of times thinner than sea level air, are so great that this heat cannot be effectively conducted.

Density and pressure, obviously very closely interlinked, decrease rapidly with altitude. The density and pressure at only 60 miles are but one-millionth their values at sea level. The air here is so thin that molecules are able to travel tens of miles before colliding with other molecules. This constitutes greater rarefaction than is present in manmade vacuum tubes, the closest man has yet come to producing a vacuum. Yet, near the outer edge of the exosphere, molecular collisions are a great number of times less frequent even than this! It is only this ultra-thinness of the upper air that permits man's artificial satellites to hurtle around the globe virtually unslowed by friction and, therefore, able to maintain for considerable times the

speeds needed to keep them in equilibrium with the gravitational forces seeking to pull them earthward.

Upper air wind speeds generally increase with altitude and sometimes show a marked "shear," or sudden change in velocity within very short alti-



World map showing lines of equal cosmic ray intensity at sea level. Intensities increase toward the polar regions. Cosmic ray equator is in zone of lowest intensity.

tude ranges: a shear of almost 100 mph was recorded within an altitude change of only .3 of a mile during a recent study of meteor trains, which occur mostly between heights of 50 and 80 miles. Also at this level, corresponding roughly to the E region of the ionosphere, drift velocities between 100 and 200 mph have been recorded by both meteor train and radio sounding techniques.

Study of scintillations of radio stars, caused by atmospheric motions, has shown drift speeds of 200 to 800 mph at an average height of 300 miles. During magnetic storms resulting from explosions and other disturbances on the sun, these drift velocities may exceed 2000 mph! Speeds as high as 400 mph, three times as fast as those near the centers of our most violent hurricanes, have been observed near the top of the stratosphere by tracking of noctilucent clouds.

In general, winds at most levels in the upper air show seasonal variation, usually flowing west-east in winter and east-west in summer. The winter winds are the stronger.

Upper Atmosphere Studies in the IGY

The IGY upper atmosphere program includes studies of the earth's magnetic field in space, cosmic rays, aurora and airglow, and ionospheric physics. Combined with these are investigations of the sun's activity and its effects on the upper atmosphere, as well as the interrelationships of upper air phenomena.

Rockets, balloons, balloon-borne rockets (or "rockoons"), and artificial satellites carrying instruments for measurement of upper atmosphere phenomena are extending the reach of science into regions which were never before accessible to direct study.

Geomagnetism. The earth is like a giant magnet, its field of magnetic force looping many earth radii into space from the main points of focus at the geomagnetic poles. Because the earth's magnetic field influences upper atmosphere events, bending cosmic rays and solar particles toward the poles and seriously disturbing the ionosphere during times of heightened solar activity, it is the subject of intensified study during the IGY. Many newly established geomagnetic stations are operating throughout the world. U.S.-IGY stations are located in the continental United States, in polar and Pacific areas, and also cooperatively in South America.

The relation of the three great upper atmosphere electric current systems—which circle the polar and equatorial regions with intensities of several hundred thousand amperes—to observed magnet effects is being studied by carefully spaced chains of these stations. Eastern Pacific stations operated by the U.S. Coast and Geodetic Survey have already reported tentative confirmation of the existence of the equatorial "electro-jet," which is believed to be the narrow neck of the broad equatorial current.

Cosmic Rays. Although their sources and exact natures are still in doubt, cosmic rays—electrically charged particles continuously bombarding the earth from space—have been known for almost 50 years. These particles, having energies of hundreds of millions of electron volts, are considerably influenced by the magnetic field as they pour toward the earth at velocities sometimes approaching the speed of light. Higher-energy cosmic rays may penetrate the atmosphere at the equator, but the relatively lower-energy rays are deflected by the magnetic field and penetrate only in the vicinity of the poles.

Analysis of cosmic rays has already made possible an improved understanding of the structure of the atom, contributing greatly to the recent conquest of atomic energy. Further study during the IGY and afterward is expected to reveal a considerable amount about the enormous energy sources of the universe.

Investigators (there are some 20 U.S.-IGY cosmic ray stations) have recently shown that the "cosmic ray equator," the zone of minimum cosmic

Every science student can afford — and will profit from using —

MENTOR BOOKS · SIGNET KEY BOOKS

AUTHORITATIVE, READABLE BOOKS IN ALL FIELDS
ONLY 35¢ • 50¢ EACH

Forthcoming

THE ORIGIN OF SPECIES (April)
Charles Darwin — *Mentor MD222, 50¢*

SATELLITES, ROCKETS AND OUTER SPACE (May)
Willy Ley — *Signet Key Ks360, 35¢*

Astronomy

NEW HANDBOOK OF THE HEAVENS
Bernhard, Bennett and Rice — *Mentor MD114, 50¢*

THE BIRTH AND DEATH OF THE SUN
George Gamow — *Mentor MD120, 50¢*

THE CREATION OF THE UNIVERSE
George Gamow — *Mentor MD214, 50¢*

FRONTIERS OF ASTRONOMY
Fred Hoyle — *Mentor MD200, 50¢*

THE NATURE OF THE UNIVERSE
Fred Hoyle — *Mentor MD125, 50¢*

Biological Sciences

EVOLUTION IN ACTION
Julian Huxley — *Mentor MD204, 50¢*

SEEDS OF LIFE
John Langdon-Davies — *Signet Key Ks345, 35¢*

THE MEANING OF EVOLUTION
G. G. Simpson — *Mentor MD66, 50¢*

THE WEB OF LIFE
John H. Storer — *Signet Key Ks333, 35¢*

THE HUMAN BODY and How it Works
Elbert Tokay — *Signet Key KD355, 50¢*

Physics

ELECTRONICS FOR EVERYONE
Monroe Upton — *Signet Key KD351, 50¢*

Earth Sciences

HOW TO KNOW AND PREDICT THE WEATHER
R. M. Fisher — *Signet Key KD353, 50¢*

BIOGRAPHY OF THE EARTH
George Gamow — *Mentor MD138, 50¢*

HOW TO KNOW THE MINERALS AND ROCKS
Richard M. Pearl — *Signet Key KD346, 50¢*

THE CRUST OF THE EARTH
Rapport and Wright — *Signet Key Ks330, 35¢*

Engineering

FLIGHT INTO SPACE
J. N. Leonard — *Signet Key Ks317, 35¢*

Geography

THE SEA AROUND US
Rachel L. Carson — *Mentor M100, 35¢*

Medicine

MEDICINE AND MAN
Ritchie Calder — *Mentor MD217, 50¢*

Science in General

THE UNIVERSE AND DR. EINSTEIN
Lincoln Barnett — *Mentor M71, 35¢*

ON UNDERSTANDING SCIENCE
J. B. Conant — *Mentor MD68, 50¢*

ONE, TWO, THREE . . . INFINITY
George Gamow — *Mentor MD97, 50¢*

SCIENCE AND THE MODERN WORLD
Alfred N. Whitehead — *Mentor MD162, 50¢*

Zoology

HOW TO KNOW THE BIRDS
Roger T. Peterson — *Signet Key KD347, 50¢*

See these and other science books at Booth #52, NSTA Convention, Denver . . . or send for our free catalog

THE NEW AMERICAN LIBRARY OF WORLD LITERATURE, INC.
Box ST-1, 501 Madison Avenue New York 22, N. Y.

ray intensity, is subject to systematic deviation from the geomagnetic equator. The studies leading to this conclusion were conducted with neutron-pile monitors at sea and with instruments carried on airplane flights. Rocket-borne cosmic ray experiments have led to the discovery for the first time of X rays in the high atmosphere associated with activity on the sun and causing increased ionization in the lower ionosphere.

Aurora and Airglow. Much IGY effort is concentrated in the study of auroras because of their relation to solar disturbances. U.S. scientists manning 39 stations, along with hundreds of volunteer observers, are using "all-sky cameras," radar, and systematic visual observation methods to study the brilliant, shimmering lights.

British scientists using radar have already proved true a long-suspected but previously undemonstrated belief that auroras occur simultaneously in both the Northern and Southern Hemispheres.

Charts of night airglow variations and movements are now being constructed by IGY scientists on a routine basis. This strange subvisual luminosity in the night sky, caused by oxygen and hydroxyl radical (OH) emissions, is greater than starlight on a moonless night.

Ionospheric Physics. The ionosphere's importance for radio communication makes it a subject of special study during the IGY. Ionospheric studies, as might be expected, are conducted mainly through the transmission and reception of radio signals. One of the major goals is the ability to predict ionospheric conditions, which may become highly turbulent during periods of solar activity.

Already during the IGY, study of "whistlers" (radio signals of descending pitch that originate from lightning flashes, arc thousands of miles into space along the magnetic lines of force, and return to earth at the corresponding point in the opposite polar hemisphere) suggests that the ionic density and molecular concentration in the earth's atmosphere at distances of as much as 8000 miles may be much greater than previously suspected. This lends weight to a theory that there may be an extremely tenuous atmosphere—possibly actually the sun's pervasive corona—between the earth and sun.

As man develops the ability to soar higher and higher, as communications systems become more complex, as scientific curiosity grows, the upper atmosphere becomes ever more important. It stands among the last earth frontiers. The world-wide, multinational IGY attack on this frontier is one of the greatest scientific adventures ever attempted. It promises to be one of the most fruitful as well.

Consider **OXFORD** *Workbooks* **NOW** *for more resultful teaching in next Year's classes . . .*

WIDELY accepted and endorsed by leading schools, OXFORD Workbooks make for easier, faster learning, for better retention of key facts, and for more effective teaching. They are classroom-tested, up-to-date, and fully meet the needs and facilities of *today's schools.* We invite you to evaluate the exceptional features of the workbooks listed below in your subject field. In providing a choice of OXFORD Workbooks, it enables teachers to make yearly changes or modify programs for different classes.

● ACTIVITY UNITS IN PHYSICS
(Revised 1957 edition)
Schnack & Suchy — Net $1.25; A or B Tests: 15¢

● DIRECTED ACTIVITIES IN PHYSICS
Brooks & McMahon — Net $1.25; A, B or C Tests: 15¢

● ACTIVITY UNITS IN CHEMISTRY
Duskin & Rawson — Net $1.25; A or B Tests: 15¢

● DIRECTED ACTIVITIES IN CHEMISTRY
Baisch & Gladieux — Net $1.25; A, B or C Tests: 15¢

● ACTIVITY UNITS IN BIOLOGY
Taylor & Vandling — Net $1.25; A or B Tests: 15¢

● DIRECTED ACTIVITIES IN BIOLOGY
(Revised 1957 edition)
Weckstein & Poster — Net $1.25; A, B or C Tests: 15¢

● EXPERIMENTS IN HIGH SCHOOL BIOLOGY
McGill — Net 90¢

● DIRECTED ACTIVITIES IN GENERAL SCIENCE
Book III · Ninth Year
Baisch & Gladieux — Net $1.25; A or B Tests: 15¢
Book I • 7th Year — Net 72¢; Test: 15¢
Book II • 8th Year — Net 75¢; Test: 15¢

● GENERAL SCIENCE WORKBOOK · Ninth Year
Burdick & Dudleston — Net $1.00; A, B or C Tests: 15¢

Teacher's key free with orders.
Send for examination copies.

OXFORD BOOK COMPANY
222 Fourth Avenue • New York 3

NSTA Activities

Safety in Science

The necessity for taking safety precautions when potential hazards are involved in science experiments has long been a concern of the alert science teacher. Now, with the almost daily newspaper stories of injuries to student scientists in rocketry and similar projects, the question of guarding against risks and hazards has become a concern of the general public, too.

In step with the times—in fact, almost a step ahead —NSTA, working jointly with the National Education Association's National Commission on Safety Education, is sponsoring a Committee on Safety Instruction in Science Teaching. The new committee's first meeting was held on January 26 and 27 in Washington, D. C.

As an important preliminary to developing reference materials for science teachers, the committee drafted a questionnaire to go to about 100 each of key elementary and secondary school science supervisors. Emphasized in the covering letter was the idea: *Safety education can give us freedom to explore.* The supervisors were asked for data on four essential points.

"1. Describe successful procedures that you have observed teachers use to reduce or eliminate common safety hazards in science instruction.

"2. Describe hazardous situations for which no satisfactory solution has been found.

"3. Describe some effective methods that you have seen teachers use to help students learn basic principles of safety.

"4. List the science teacher(s) in your school system whom you consider to have been especially effective in helping students become safety conscious."

The replies, due March 1, are to be classified and evaluated by specified members of the committee. The results will be considered at the next meeting of the committee which is scheduled for April 19 and 20.

With the help of the data thus obtained, the committee now plans to develop articles and/or leaflets which can serve as a guide to the science teacher on safety hazards, good safety practices, and the teaching of safety concepts. Current plans call for publication of the reports in *The Science Teacher* and/or distribution in NSTA packets. The committee subsequently plans to compile a brochure from the tested leaflets.

At its initial meeting, the committee agreed on three guideposts in its work: (1) to give the teacher a more secure feeling in handling science materials (most important at the elementary level); (2) to develop the safety consciousness of the teacher; and (3) to prepare students for safe individual experimentation.

Chairman of the new committee is Dr. Willard Jacobson, Teachers College, Columbia University, New York City. The other members are: Grace L. Coe, biology teacher, Kearny, New Jersey, High School; James V. DeRose, head of the science department, Chester, Pennsylvania, High School; Carl Doebler, driver education teacher, Toledo, Ohio, Public Schools; Dr. Floyd M. Farmer, Wichita, Kansas, Public Schools; Dr. Arthur Hoppe, School of Education, Indiana University, Bloomington; Dr. Marion Nesbitt, Richmond, Virginia, Public Schools; and Alexina G. Stidham, junior high science supervisor, Baltimore, Maryland, Public Schools.

Chemistry Films

An experiment in chemical education is under way at the University of Florida where a complete course in high school chemistry is being prepared and filmed. The project had its initiation in discussions between officers of The Fund for the Advancement of Education and the American Chemical Society (ACS).

Dr. John F. Baxter, professor of chemistry at the University of Florida, Gainesville, was selected to teach the filmed course. ACS, with cooperation from its Division of Chemical Education and the National Science Teachers Association, appointed a committee to serve in an advisory capacity.

The members of this committee are: Dr. A. B. Garrett, The Ohio State University, Columbus, chairman; Dr. Lawrence Bromberick, North Shore High School, Glen Head, New York; Dr. J. A. Campbell, Harvey Mudd College, Claremont, California; Christine Jansing, J. M. Atherton High School, Louisville, Kentucky; Dr. W. F. Kieffer, College of Wooster, Ohio; Dr. C. A. VanderWerf, University of Kansas, Lawrence; and Dr. Roy Whistler, Purdue University, Lafayette, Indiana.

Assisting full time on the project are Raymond T. Byrne, on leave from the high school in Batavia, New York, and Dr. Donald B. Summers, on leave from Columbia High School, Maplewood, New Jersey. Dr. Ned Bingham, professor of science education at the University of Florida, is a consultant to the project.

Film production and distribution will be done by Encyclopaedia Britannica Films, of Wilmette, Illinois, under a contract with The Fund for the Advancement of Education. Present plans call for the films to be available for use during the school year 1958-59. They are being produced to help alleviate the shortage in qualified teachers of chemistry and to assist overworked science teachers throughout the country.

Graf-Apsco

GRAF APSCO

STUDENT MICROSCOPES

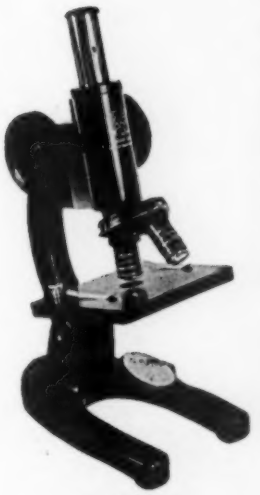
Model GB2

GENERAL BIOLOGY MODEL

This instrument has:
A FULL fine adjustment
All METAL coarse adjustment rack and pinion
Plano-concave mirror
STANDARD 16mm and 4 mm objectives
Mirror specially mounted so it cannot fall out.
Huyghenian ocular 10x
Achromatic objectives: 16mm (10x) and 4 mm (44x)
Disc diaphragm
Price: $118.00 (we pay transportation)
Less 10% on 5 or more

ELEMENTARY BIOLOGY MODEL

This instrument equipped:
Same as above but without fine adjustment.
By using large buttons we have retarded the coarse adjustment action to insure easy focusing without a fine adjustment.
Price: $97.50 Less 10% on 5 or more
NO INCREASE IN PRICE.



Model EB2

Sold on ten days approval.
Old microscopes accepted in trade.

THE GRAF-APSCO COMPANY

5868 Broadway **Chicago 40, Ill.**

FOR SCHOOLS! FOR HOME! FOR DISCUSSION GROUPS! FOR NON-MUSICAL RECREATION!

SPOKEN ARTS proudly presents for the first time on a 33⅓ long playing record:

DR. EDWARD TELLER discussing
"The Size and Nature of the Universe"
"The Theory of Relativity"

Dr. Edward Teller, theoretical physicist, lecturer, and man of wisdom and wit, is fond of quoting that "A specialist is someone who knows more and more about less and less until he knows everything about nothing. A philosopher is someone who knows less and less about more and more until at last he knows nothing about everything."

If he were asked to describe himself in similar terms, he would probably say that he is someone who is learning more and more about more and more until at last he might possibly know a little about a little. This would be characteristic of his modesty, which finds its match for magnitude only in the scope of his mind.

The discussions he presents on this record were originally made informally at the home of a friend in answer to various questions of other guests regarding the universe and the theory of relativity. As a teaching aid it is quite beyond compare. And no better comment can be made than the following letter received from a member of the Department of Science of New Rochelle High School who writes:

"I thought you would be interested in the impressions and experiences of one science teacher with the recording entitled "The Size and Nature of the Universe" and "The Theory of Relativity," narrated by Dr. Edward Teller.

"On listening to this recording I was deeply impressed with its science content and the clarity of its presentation in important areas of science about which the average citizen knows little. More than that, however, I was excited at what I thought might be an excellent aid for use in the secondary school science program.

"I have had the opportunity to use the recording in two different science classes—one, a class in physics, and the other in a course entitled "Natural Science," for the general student. I am happy to report that the results of the use of the record were excellent. It proved to be stimulating to both classes of students, and it has served as a nucleus for the motivation of a truly functional study of many facets of science that are not generally discussed at this level. To see students become rather deeply concerned about the philosophic aspects of science in a high school classroom is quite rewarding to a teacher. I attribute this primarily to the fine motivation that was provided by the recording."

(signed) Daniel Wagner
Department of Science

SEND FOR THE DR. EDWARD TELLER RECORDING TODAY. We'll send you a booklet on "The Atomic Revolution" with it. If you don't think it is all we say just return it and we'll refund your $5.95.

MAIL THIS COUPON

SPOKEN ARTS SALES CORPORATION
95 Valley Road, New Rochelle, New York

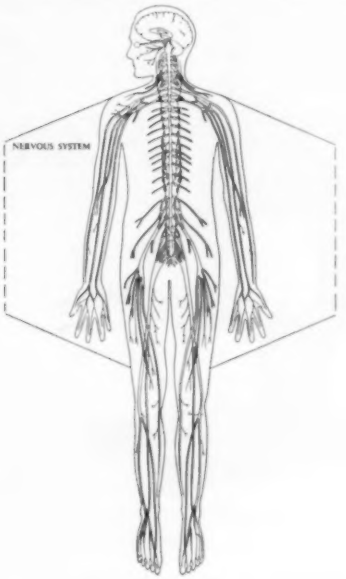
Please send me:
Dr. Edward Teller's recording of
"The Size and Nature of the Universe"
"The Theory of Relativity"
Complete catalogue of other SPOKEN ARTS releases.
I enclose $5.95 (check or money order) in full payment.

Name.....

Street.....

City..... Zone..... State.....

Turtox Manikins of *the* Human Body



These cut-out human manikins are used in thousands of schools. The figures are easily cut out and assembled by the student, resulting in a good reference manikin, one-seventh life size.

Price: $2.50 per dozen, or $17.00 per hundred for either manikin.

385D185 Turtox Sexless Human Manikin.
385D195 Turtox Female Human Manikin.

TURTOX PRODUCTS

GENERAL BIOLOGICAL SUPPLY HOUSE
Incorporated
8200 South Hoyne Avenue, Chicago 20, Illinois
The Sign of the Turtox Pledges Absolute Satisfaction

EXPLORING SCIENCE

for grades 1-6 *by Dr. Walter A. Thurber*

Science is a definite part of every child's life, whether it take the form of television watching or "moon-watching."

Allyn and Bacon offers a timely introduction to science that prepares children to understand basic scientific concepts through exciting experiments. Based on the philosophy that children learn best by doing, these books feature activities that encourage pupils to plan, use ingenuity and exercise initiative. In a science program created especially for them, children learn to work together, to solve problems, to handle tools and to use books . . . and they love every minute of it!

The Thurber series gives children practice in all the common areas of physical and biological science.

- all activities tested in classrooms for over ten years
- illustrations by expert artists speed learning
- special Teachers' Editions with each text

for further information write the Allyn and Bacon office serving your state

ALLYN AND BACON, INC.
San Francisco Englewood Cliffs, N.J.
Boston Atlanta Dallas Chicago

MADDUX . . . from page 75

apt to be as interested in plants as the other phases of science, it does not seem wise to discard the study for that reason.

I recall one boy I taught several years ago who became very interested in wild flowers and trees. I took him with me when I labeled one of the nature trails for our Metropolitan Park Board. By the time he left the sixth grade he knew most of the common plants in our area. After four years with Uncle Sam he is graduating in January from Purdue University in forestry. He says his interest began in elementary school.

Some teachers think children are not interested in the geology units. I think that is usually because the teachers have no background in the subject themselves. I can name two boys who have developed a lifelong interest from their exposure to geology in the elementary school. One boy graduated from the School of Mines at Golden, Colorado and is working for an oil company. Another showed a great interest and I suggested he volunteer to help at our Museum of Natural History. He graduated in paleontology at Yale University and is now doing graduate work at Columbia University. For two summers he has headed an expedition excavating a dinosaur in Colorado. A well-rounded program will be more likely to help children find their special interests.

6. Some schools prefer an integrated science program, usually with the social studies. My observation has been that science becomes incidental to the social studies and is something talked *about* rather than made a subject of discovery and experimentation. Herbert Zim says science means the gaining of facts pertinent to the solution of a problem. When a unit becomes too comprehensive, it sometimes loses real science teaching techniques. A very skillful teacher with an equal interest in science and social studies can probably make it work, but I suspect a lack of skillful teachers in these days of shortage.

My experience has been that children have a natural interest in science and that it does not need any outside motivation. They like to feel they are studying science. Certainly today, with science being discussed on TV and radio, children are aware of science as a "subject" and I see no harm in labeling it.

The scientists produced under the European system certainly know of science as a special subject in the curriculum. There are many subjects that can be integrated with science, however. Science can motivate reading and mathematics, it can furnish opportunites for both written and oral English; science can also form the basis for creative art work.

A planned program does not need to preclude incidental science teaching. Certainly children should be encouraged to bring in things that interest them and ask questions about them. No child should be told, "We are not interested in frogs today because our unit is simple machines." Johnny can show his frog to the class, tell where he found it, and what he knows about it. Other children may make observations and the teacher may suggest a book to give Johnny more information. A few minutes of time will satisfy and encourage him. It would be impractical to follow all these leads and develop an entire unit around each passing interest.

To summarize: a planned program provides for progress from simple to complex understandings. It eliminates repetition. It gives the teacher a feeling of security. Planning does not mean a static program but one that should be frequently re-evaluated. A planned program also eliminates the possibility of a teacher emphasizing her own hobby or the interest of the most aggressive member of the class.

SPECIAL COURSES
AT LAKE ITASCA FORESTRY
AND BIOLOGICAL STATION
Minnesota
SUMMER SESSION
FIRST TERM
June 16—July 19
SECOND TERM
July 21—Aug. 23
GRADUATE STUDY with distinguished faculty
UNDERGRADUATE WORK in all regular schools and colleges offering more than 1000 outstanding courses
LIBRARY, LABORATORY, and RESEARCH facilities of excellent quality
SPECIAL WORKSHOPS and INSTITUTES
RECREATION — symphony and other concerts — plays — lectures — excursions — golf — tennis — swimming — athletic program — on campus in a cultural center located in a playground of 10,000 lakes.
For Bulletin write Dean of Summer Session, 837 Johnston Hall
UNIVERSITY of MINNESOTA
MINNEAPOLIS 14, MINNESOTA

FSA Activities

West Coast Conference

This year, for the fifth successive summer, the Crown Zellerbach Foundation and the Future Scientists of America Foundation will co-sponsor a summer conference for West Coast science teachers. The 1958 sessions are being set up for junior high school teachers of general science. There will be 32 Fellows selected from schools in Washington, Oregon, and California.

The dates for the 1958 conference will be June 15 through July 3. The place will be Oregon State College, at Corvallis. As the host institution, the college will also be a co-sponsor of the sessions.

The conference will be a working conference with a significant share of it devoted to the production of a report on the teaching of junior high school general science. The report will be made available for wide distribution as a service to the profession. The planners of the conference point out that this distribution will take the benefits of the meetings far beyond the regional setting of the conference itself.

The co-directors of the sessions will be Dr. Stanley E. Williamson, professor of science education at Oregon State College, and Dr. J Ned Bryan, director of the National Education Association's *Academically Talented Pupil Project*. Dr. Bryan is serving as director on a year's leave of absence from his post as professor of science education at Rutgers University.

There will be stipends and travel allowances for the Fellows who will be selected from teachers nominated by their junior high school principals. Nominations should be sent directly to the Future Scientists of America Foundation, 1201 Sixteenth Street, N.W., Washington 6, D.C. FSAF, in turn, will send application forms and other pertinent data to eligible nominees.

Administrative Committee

The FSAF Administrative Committee will meet about May 10 to begin planning for the 1958-59 school year program. NSTA members and other science teachers who have utilized FSAF offerings or who have taken part in or are interested in its programs are urged to submit ideas and advice. Particularly wanted are suggestions for new activities appropriate for the Foundation to consider as possible additions or modifications of the present action program.

Certain FSAF activities are almost sure to continue. These include the annual program of Science Achievement Awards for Students, the research team summer conferences for science teachers, and the FSAF booklet services. However, FSAF, with its background of successful science-stimulating programs despite its comparative youth, is in a key position to be a leader at a time when the general public is deeply interested in youth science programs. Concurrently, business-industry appears willing to take on more financing of such programs. FSAF, therefore, needs the help of science teachers in proposing and developing additional activities which will capture the enthusiasm of youth and the appreciation of the adult public.

Teachers should communicate directly with the chairman of the FSAF Administrative Committee: Dr. Stanley E. Williamson, Professor of Science Education, Oregon State College, Corvallis, Oregon.

On-the-Job Research

It is encouraging that there appears to be a growing interest on the part of potential sponsors in the type of project represented by the FSAF on-the-job research program for secondary school science teachers. As a means of developing this interest, FSAF is eager to obtain sound proposals for its research grants.

The FSAF subcommittee which evaluates the proposals and allots the grants is scheduled to meet again about May 1. It is the group's hope at that time to make additional grants in the pilot run of the program, which was reported last December. (See "Research Grants," *TST*, December 1957, page 408.)

Three things are basic to proposals for FSAF on-the-job research grants. They are:

1. The teacher must thoroughly define the research problem proposed, showing that it is feasible for him or her to undertake it in his particular classroom situation and demonstrating that the on-the-job research would involve the participation of able students.

2. There must be assurance of support or approval by the school authorities for the research project to be carried on during the school year.

3. There must be assurance that a competent scientist or other appropriate person is available to guide and advise the teacher with the project.

Suggestions and guidelines for drawing up applications for grants are available at FSAF, 1201 Sixteenth Street, N.W., Washington 6, D.C. These should be requested immediately since the actual applications should be submitted well ahead of the anticipated May 1 meeting of the subcommittee. Applications should be mailed to: On-the-Job Research Committee, Future Scientists of America Foundation, 1201 Sixteenth Street, N.W., Washington 6, D. C.

He flew the **Bell X-2** *1,900 m.p.h.*
He was the chief test pilot for the U. S. Air Force for 5 years—
His speed and altitude records have never been equaled—

THE FASTEST MAN ALIVE

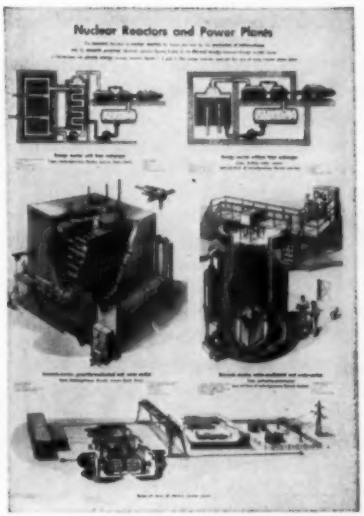
The Autobiography of Lt. Col.
FRANK K. EVEREST, Jr., U.S.A.F.
As told to John Guenther

America's greatest test pilot who risked his life to solve the mysteries of space and speed for science—tells of his work on the hazardous front lines of aviation research. He flew the famous *Bell X-2* from the first glide flight to its record of almost 3 times the speed of sound. He worked under General Albert Boyd, father of modern flight testing; his friends are among the immortals of aviation—men who proved our first jets, flew the first rocket planes, were first to break the sound barrier. His life story dramatizes as never before the problems of the pioneers of future space exploration—the engineers and pilots who risk their lives at new speeds and new heights to explore the unknown itself. Action photographs. $4.00.

E. P. DUTTON, 300 Fourth Avenue, New York 10, N.Y.

VISUALIZING CONSTRUCTIVE USE OF ATOMIC POWER . . .

Here is a chart which beautifully supplements the original set of four that is already in wide use throughout the country. Fifth in a series of six, this chart is identified with our catalog number TNAT5. The entire group of six can be obtained as a set or as individual selections, and in various styles of mounting. Size and coloring provide good carrying power in the classroom, for excellent visibility. For full information and prices on the atomic theory charts, ask for Circular S30.



DENOYER-GEPPERT
COMPANY
5245 RAVENSWOOD AVENUE CHICAGO 40

BOOK BRIEFS

BRAINPOWER QUEST. A Symposium Sponsored By The Cooper Union For The Advancement Of Science And Art. Edited by Andrew A. Freeman. 242p. $4.75. The Macmillan Company, New York. 1957.

The title of this little volume is misleading. This is unfortunate, for a truly impressive group of university presidents and deans, corporation heads, philosophers, science educators, and government chiefs were gathered together by The Cooper Union to consider ways and means of awakening the public to the need for better recruitment and education of our future scientific and engineering talent.

As it turned out, most of the speakers devoted their time to an elaboration of what is wrong with our world, the American-Soviet manpower race, and what kind of engineers we ought to have.

For the most part, the creative aspects of the speakers' intelligence was denied the listeners—and the reader. The lack of adequate time, perhaps, to develop their themes and elaborate their ideas resulted in a compilation of cliches and platitudes concerning the confusions of a democracy in a culture having a scientific and technological base. These notions have been well known to many people for a long time.

This publication does two things: first, it presents a convenient collection of authoritative statements on the gravity of the problem of the critical national shortage of scientific and engineering manpower; and second, it provides evidence of striking unanimity concerning the need for scientists and engineers to be exposed to more academic background in the social sciences and the humanities.

ISRAEL LIGHT
U. S. Public Health Service
Washington, D. C.

VAN NOSTRAND'S SCIENTIFIC ENCYCLOPEDIA. 1839p. $30. D. Van Nostrand Company, Inc., Princeton, N.J. 1958.

Third edition, completely revised, updated, reset. Basic reference work, comprehensive, informative. Includes 14,000 separate articles, 100,000 definitions. Ranges from aeronautics to zoology, including electronics, guided missiles, nuclear science and engineering. Profusely illustrated in black and white, color. Instructive to science student as well as working scientist and science teacher.

GUIDE TO THE MICROSCOPE. Arthur Beiser. 127p. $3.25. E. P. Dutton & Co., Inc., New York. 1957.

Comprehensive, explicit data on how the microscope works, how to select one, how to use it. Practical guide for students.

PHYSICAL SCIENCE FOR LIBERAL ARTS STUDENTS. Hugo N. Swenson, J. Edmund Woods. 333p. $6.50. John Wiley & Sons, Inc., New York. 1957.

Illustrated, handsomely designed text reporting how the science structure grows, how the natural sciences differ from other intellectual fields. Of interest to science as well as liberal arts students.

A SCIENTIFIC VOCABULARY FOR BEGINNING ZOOLOGY STUDENTS AND NON-SCIENTIFIC STUDENTS. Mary J. Brown. 104p. $3.00 Pageant Press, Inc., New York. 1957.

Definitions, pronunciations of more than 1400 zoological terms commonly occurring in the beginning college course.

THE SPACE ENCYCLOPAEDIA. M. T. Bizony, General Editor. 287p. $6.95. E. P. Dutton & Co., Inc., New York. 1957.

Informative, detailed text and reference book for all interested in today's and tomorrow's news. More than 300 illustrations, maps, diagrams.

FINDING FOSSIL MAN. Robin Place. 126p. $7.50. Philosophical Library, New York. 1957.

How scientists have evolved the history of man's development through fossilized remains. Nearly 100 photographs and line drawings.

As a new feature of *The Science Teacher*, Bulletin Board will appear when pertinent items warrant its publication. It will carry notices from *TST*'s editors, from NSTA, and from NSTA members or other science teachers who may wish to use it. Its subject matter can be classified "miscellaneous," ranging from such items as the two listed below to requests from teachers trying to locate out-of-print books, etc. No commercial items, of course—and *TST*'s editors reserve the right to determine the publication suitability of notices submitted. Write to: Bulletin Board Editor, *The Science Teacher*, 1201 Sixteenth Street, N. W., Washington 6, D. C.

WANTED: October 1957 Issues of *THE SCIENCE TEACHER*. NSTA's stock of this issue of the journal is virtually depleted and must be built up. Members who have no further use for their copies are asked to help. For the first 50 copies returned in good condition, $1 will be paid to the sender of each. Mail in a manila envelope preferably with cardboard enclosed to: *The Science Teacher*, 1201 Sixteenth Street, N. W., Washington 6, D. C.

IGY REPRINTS: The IGY articles being published in alternate issues of *The Science Teacher* during the current school year are available in reprint form to individuals. The articles to date are: *Weather, Sea, and Ice Studies in the IGY* by Roger Revelle (October 1957 *TST*); *Earth, The Changing Laboratory: An IGY Report* by Maurice Ewing (December 1957 *TST*); and *To the Edge of Space: IGY Upper Atmosphere Studies* by Alan H. Shapley in this issue. Individuals wanting reprints should write to: The Director of Information, International Geophysical Year, National Academy of Sciences, Washington 25, D. C.

BLANC . . . from page 83

to indicate that knowledge of principles is feasible at the junior high school level, and that a program of laboratory experiences at this level is not only feasible, but justified.

To try to find in what elementary grade selected principles of physical science should be introduced, Leonelli (8) asked specialists in elementary science and elementary science teachers to rate principles extracted from a previous study in terms of (a) inclusion of the principle, (b) reason for inclusion, and (c) grades where the principle should be introduced. The results indicate that 70 of the principles could be included at the elementary level.

Studies by Oxendine (13), McCarthy (11), and McCollum (12) tried to pinpoint the placement of one specific principle at a definite grade level. It is felt that the conclusions reached by these investigators were based on such restricted data that no positive trends could be discerned. However, this is not to indicate that it would not be desirable if some *accurate* method were developed which would allow a curriculum to be based partially on this type of evidence. Such a development would be a most valuable contribution to science education.

General Trends in Research

In a summary of research in secondary school science teaching, Mallinson (9) presents a number of conclusions:

1. Certain concepts cannot be developed satisfactorily with younger students. Proper placement of all important concepts should be made.
2. An integrated sequence of general science for grades seven, eight, and nine is the most desirable program for the junior high school since students who have had general science throughout the junior high school show superiority in later courses in science over students who have not.
3. If attitudes are objectives, they should be taught directly, since the mere study of science does not make a unique contribution to attitudes. Marked improvement in scientific thinking is evidenced when specific attention is given to obtaining this outcome.
4. There is a definite need for more direct teaching and testing for the understanding of principles and for the development of scientific attitudes and skills.
5. The increasing development of integrated courses in physical science is significant.

Hurd (7), in a study of science teaching at mid-century, predicts that in the next few years there will be many changes in the science curriculum. He believes that the new type curriculum will be adapted to the conservation of human resources and should be structured to increase man's adjustment to the physical and biological world. He found that more courses are being organized around science principles than at any time in the past.

In a look at science teaching, past and future, Brown (2) gives the trends in course of study reorganization as follows:

1. There will be a continuous, integrated K-12 curriculum in science in the school program with some type of guide to insure a sequence of learnings.
2. Elementary courses in science will deal with an exploration of problems in the child's environment. Integrated courses, as general science and biology, will be retained at the ninth and tenth grades and general physical science will be offered at the 11th and 12th grades.
3. There will be greater study of scientific principles and their applications in all ways of life by means of a psychological arrangement of the curriculum rather than a logical arrangement.

Smith (17) made a study of trends relating to time devoted to general science, topical coverage, and pupil enrollment during 1945-1955 in over 100 junior high schools. The results indicate that general science has gained in periods per week at each grade level with the seventh grade showing

"What I Really Want Is a Few Jars of Instant Science"

HERBLOCK IN THE WASHINGTON POST

To spur students' interest in science . . .

To ready them for MORE science . . .

four problem-solving texts by Beauchamp, Mayfield, and West:

- **Science Problems 1**
  for Grade 7
- **Science Problems 2**
  for Grade 8
- **Science Problems 3**
  for Grade 9
- **Everyday Problems in Science**
  for high-school general science courses

SCOTT, FORESMAN AND COMPANY *Chicago 11 • Atlanta 5 • Dallas 2*
Palo Alto • Fair Lawn, N.J.

the greatest gain and the ninth grade the least. There was also an appreciable gain in time in minutes for science at each grade level and a gain in enrollment. No significant pattern appears from the replies to the question on approximate distribution of subject-area content covered in general science instruction. All content areas appear in the instructional program, but emphasis differs from school to school.

March 25, 1958: NSTA Pre-Convention Conference for Supervisors, Denver, Colorado
March 26-29, 1958: NSTA Sixth National Convention, Denver, Colorado
March 27-29, 1958: American Physical Society, Chicago, Illinois
April 12, 1958: National Council for Elementary Science, Atlantic City, New Jersey
April 13-18, 1958: 133rd National Meeting, American Chemical Society, San Francisco, California

In an article devoted to the future of science teaching, Anderson (1) proposes to remedy the fact that superior students are not going into science by providing a two-track plan to enable the talented pupils to pursue the sciences more extensively in high school. He would have the "lower track" pupils take two years of science, general biological and general physical, at the ninth and tenth grades. These courses would be nonlaboratory with the emphasis on demonstrations, audio-visual aids, field trips, speakers, and so forth. For the accelerated pupils he proposes a four-year sequence of science courses, grades nine through 12. His comment is that such a two-track system should provide students of average scientific ability with the basis for intelligent living in a scientific age and extend or stretch the ability of students of superior scientific ability "well beyond the mediocre threshold now reached by them."

In a summary of major findings in 51 pieces of research into major implications for elementary and

secondary science teachers, Washton (18) makes this interesting statement: "If all of our science teachers in America were to put into practice most of the above mentioned findings and recommendations based upon educational research, we could expect a more economical, effective, and inspirational program of science offered to our youth."

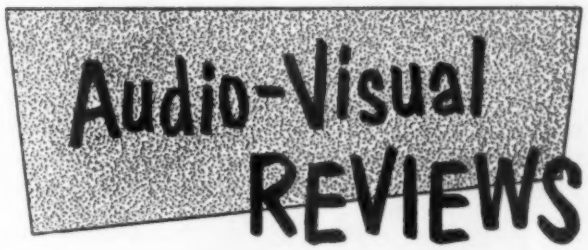
Conclusions

An analysis of the studies concerned with the selection and grade placement of science experiences indicates a great lack of agreement and uniformity. It is evident that an attempt to select the proper grade level at which topics or principles of science should be introduced is somewhat futile. What science to offer in one grade and what to leave for later grades has always been a problem and seems likely to continue to be one for some time. At present, no quantitative distribution of subject matter can be justified, for highly selective choices of topics to be taught at specific grade levels would be open to serious question.

The research studies concerned with the teaching of science in the elementary school indicate that in the area of curriculum development a steady growth of elementary science has taken place. The objectives of science teaching are now fairly well established, though research tends to indicate that implementation of these objectives has not always occurred. Science is becoming a definite part of the elementary curriculum in most school systems. The value of organizing the course around large subject-matter areas is now generally accepted, although surveys of current practices indicate that some elementary science instruction still centers around the teaching of small, isolated topics.

The science teacher who would judge the results of his teaching must have a clear idea of what he is teaching and why. Research has shown that teachers considered expert in teaching elementary science agree rather well with the topics presented in most courses of study. However, if the aim is merely to cover the outline, most of the values which science education can provide will be lost. Growth in learning is continuous and the pattern differs from one child to the next. Hence, even though principles of science are being consulted more frequently than ever before in the preparation of science curricula, there seems to be no evidence as to a definite age level at which specific science experiences can be taught most appropriately. The final test is how well the children meet the problems of learning and living day by day.

Trends in the enrollment and in the planning of science courses in both the junior and senior high



THE HUMAN CELL AND THE CYTOTECHNOLOGIST. 22½ min. 1957. $135 Color; free on loan for educational showings. National Committee for Careers in Medical Technology, 1785 Massachusetts Ave., N. W., Washington 6, D. C.

Recommendation: Ninth-grade general science; high school biology and vocational guidance; and college biology, cytology, and counseling areas. Also for adult and lay groups in public information programs.

Content: Underlining a modern approach to cancer detection, the film follows the activities of a cytotechnologist, laboratory technician in the field of human cell classification and identification. Basic scientific information is presented through effective animation sequences, alternating with unusual photomicrographs of actual cells. Present knowledge about cancer, the process of growth, exfoliation, and metastasis are among the themes highlighted. The film is also useful for career guidance. The importance of specific knowledge, good training, and the sense of personal satisfaction and service stand out as the processes of taking specimens, preparing slides, and identifying possible malignancy are shown.

Evaluation: Timely, dramatic, and effective presentation of the story of medical technicians, their fight against cancer, and the important role they play in public health. Color, sound, and photography are uniformly excellent.

◇ ◇ ◇

WHY EAT A GOOD BREAKFAST? Color, 34-frame filmstrip with captions. 1957. Single copies free on a permanent loan basis to school film libraries. Educational Director, Cereal Institute, Inc., 135 South LaSalle St., Chicago 3, Ill.

Recommendation: Junior and senior high school levels.

Content: Based on the Iowa University "Breakfast Studies," a scientific survey by the university's College of Medicine, the filmstrip depicts the planning and supervision of this research as well as how the tests were conducted and recorded. The survey's results demonstrate the importance of a good breakfast.

Evaluation: Interesting presentation which makes an excellent device for stimulating youth to eat a good breakfast. The points made are substantiated with reliable research data.

◇ ◇ ◇

PROTOZOA. 11 min. 1957. $50 B & W, $100 Color. Encyclopaedia Britannica Films, 1150 Wilmette Ave., Wilmette, Ill.

Recommendation: High school general science and biology, college biology, and beginning zoology areas.

Content: Protozoa are classified and feeding habits and fission of various protozoa are shown, as are examples of symbiosis and parasitism.

Evaluation: Excellent color, sound, photography, commentary. Review material is especially valuable.

schools emphasize the needs of the consumers of science. The number of pupils in the less formal science courses and the variety of science courses offered have increased. Unification of biological sciences into one course is an established fact. Further unification of physical sciences is growing. These trends further indicate the following:

1. Continuous, integrated, articulated programs in science K-12 are the accepted plan.
2. Courses of study are being organized with major principles of science in view.
3. There is consideration of general science courses at the high school level for pupils not especially talented in the field of science.

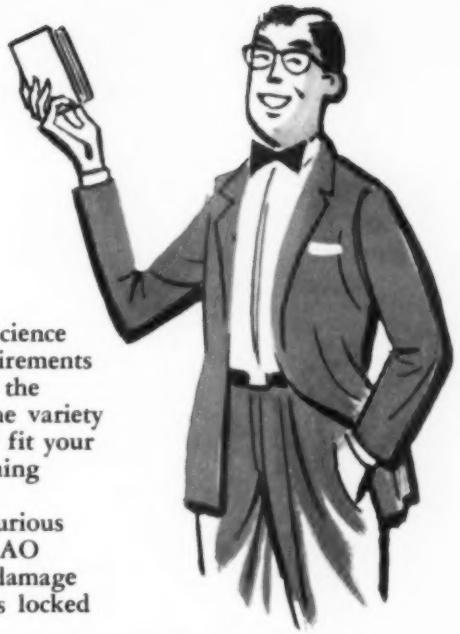
Bibliography

1. Anderson, Kenneth, "Looking Ahead in Science Teaching." *Science Education,* 40:379-381, December 1956.
2. Brown, Stanley, "Trends in Science Education." *The Science Teacher,* 21:84-85, March 1954.
3. Bruner, H., *What Our Schools Are Teaching.* Bureau of Publications, Teachers College, Columbia University, 1941.
4. Dubins, M. Ira, "Current Practices in Elementary School Science with Reference to Courses of Study Published from 1940 to 1952, and the Extent of Activities Undertaken for the Improvement of Instruction." Unpublished doctoral dissertation, Boston University, 1953.
5. Flannigan, Norman A., "A Study of High School Science Courses in Grades Nine through Twelve Designed for General Education." Unpublished doctoral dissertation, Cornell University, 1954. (Reviewed in *Science Education,* 40:348-349, December 1956.)
6. Gilbert, Alice, "Science Content in the Elementary School." *School Science and Mathematics,* 43: 769-773, November 1943.
7. Hurd, Paul DeH., "Midcentury Trends in Science Teaching." *California Journal of Secondary Education,* 28:244-250, May 1953.
8. Leonelli, R. E., "The Selection and Grade Placement of Physical Science Principles in the Elementary School Curriculum." Unpublished doctoral dissertation, Boston University, 1952. (Reviewed in *Science Education,* 38:361, December 1954.)
9. Mallinson, George G., "The Implications of Recent Research in the Teaching of Science at the Secondary School Level." *Journal of Educational Research,* 43:321-342, January 1950.
10. Marsh, Marjory B., "Elementary Science Courses of Study Compared with Content Recommended by Some Selected Teachers of Elementary Science." Unpublished master's research paper, Ball State Teachers College, 1953. (Reviewed in *Science Education,* 39:337, December 1955.)
11. McCarthy, Francis W., "Age Placement of Selected Science Subject Matter." Unpublished doctoral dissertation, Harvard University, 1951. (Reviewed in *Science Education,* 39:338, December 1955.)
12. McCollum, Clifford G., "The Determination of Science Maturity as a Means of Improving the Program in Elementary Science." *The Science Teacher,* 20:238-240, October 1953.
13. Oxendine, Herbert G., "The Grade Placement of the Physical Science Principle, 'Sound is Produced by Vibrating Material,' in Relation to Mental Ages." Unpublished doctoral dissertation, Boston University, 1953. (Reviewed in *Science Education,* 39:338, December 1955.)
14. Skilken, Jacob, "Needed—A New Science Curriculum." *The Science Teacher,* 21:233, October 1954.
15. Smith, Herbert F., "A Determination of the Principles Desirable for a Course of General Science at the Junior High School Level." *Science Education,* 35:279-284, December 1951.
16. Smith, Herbert F., "A Determination of the Experiments Desirable for a Course of General Science at the Junior High School Level." *Science Education,* 36:32-47, February 1952.
17. Smith, Keith, "Trends in Junior High General Science." *The Science Teacher,* 23:86-88, March 1956.
18. Washton, Nathan, "Changes in Teaching from the Use of Research in Science Education." *Science Education,* 40:383-387, December 1956.

Index of Advertisers

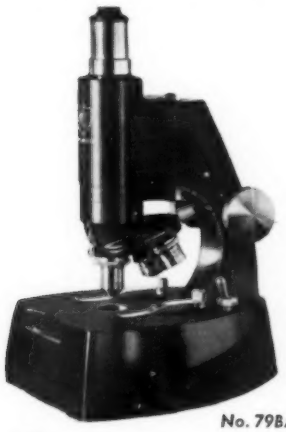
Albert Teachers Agency and College Bureau 96
Allyn and Bacon, Inc. 104
American College Bureau 67
American Optical Company ..... Cover III
Bell Telephone Laboratories 93
Cambosco Scientific Company 61
Central Scientific Company ..... Cover IV
Columbia University Press 64
Corning Glass Works 65
Denoyer-Geppert Company 107
E. P. Dutton & Company 107
Edmund Scientific Company 62
General Biological Supply House, Inc. 104
Ginn and Company 96
The Graf-Apsco Company 103
D. C. Heath and Company 63
Henry Holt and Company 58
Kewaunee Manufacturing Company ..... Cover II
J. B. Lippincott Company 60
The New American Library of World Literature, Inc. 100
Oxford Book Company 101
Rand McNally & Company 67
John F. Rider Publisher, Inc. ..... 94 and 95
Scott, Foresman and Company 110
E. H. Sheldon Equipment Company ..... 84 and 85
The L. W. Singer Company, Inc. 97
Spoken Arts, Inc. 103
Testa Manufacturing Company 66
United Scientific Company ..... 90 and 91
University of Colorado 66
University of Minnesota 105
D. Van Nostrand Company, Inc. 57
W. M. Welch Scientific Company 68

THERE'S AN AO SPENCER STUDENT MICROSCOPE TO SUIT YOUR EXACT TEACHING PLAN



What is the best teaching microscope? Thousands of Science Teachers have told us there is no single answer. Requirements differ with budget restrictions, the age of students and the course being taught. That's why AO Spencer makes the variety of models shown here. You'll find that one will exactly fit your specific needs, that all are designed to make your teaching hours more productive.

Realizing that students are at all times wonderfully curious and sometimes impetuous, focusing adjustments on all AO teaching microscopes are "spring loaded" to prevent damage to objectives and costly slides. Eyepieces and objectives locked in, if desired.



No. 79BA

78 A low-cost teaching microscope that requires little or no instruction into the technique of microscopy. Your time is spent solely on subject matter. Built-in base illuminator assures proper illumination. Helps students observe specimens properly.

Model No. 78R only **$77.40** in quantities of 5 or more.

No. 73S

73 A quality instrument with a low price tag! Designed for the class where acquisition of subject matter is the primary teaching objective. Low overall height and single precise focusing adjustments make the No. 73 easy to use. Attached substage illuminator available.

Model No. 73R only **$78.75** in quantities of 5 or more.

No. 66B

66 One of the most popular Teaching Microscopes in America! Traditional design and minimum maintainance make it ideal for the class where acquisition of subject matter *and* skill in microscopy are *both* important considerations. All metal, standard size instrument with top quality optics. Coarse and fine adjustments. Attached substage illuminator available.

Model No. 66S only **$125.25** in quantities of 5 or more.

American Optical Company

INSTRUMENT DIVISION, BUFFALO 15, NEW YORK

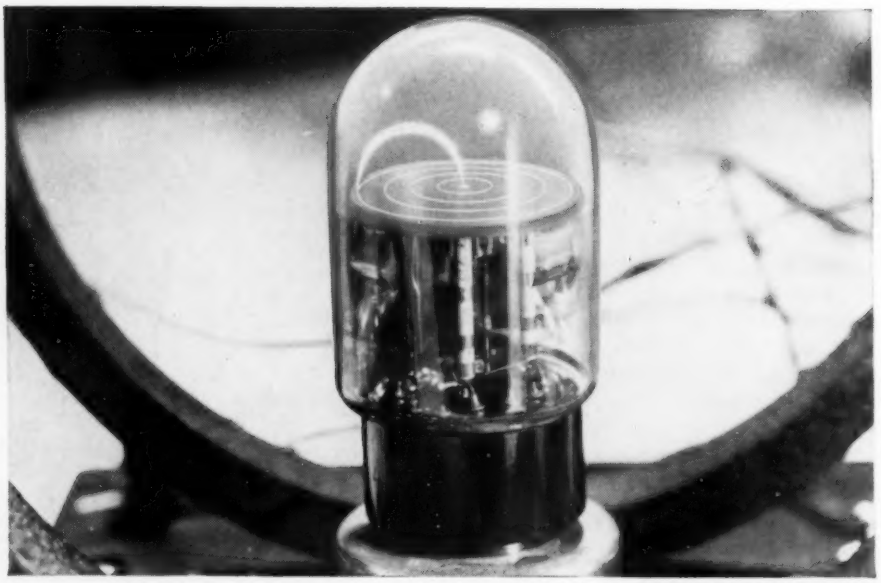
Gentlemen: Dept. C95

Please send me complete information on AO Spencer Student Microscopes, No. 66 ☐, No. 73 ☐, No. 78 ☐.

Name.....

Address.....

City..... Zone..... State.....



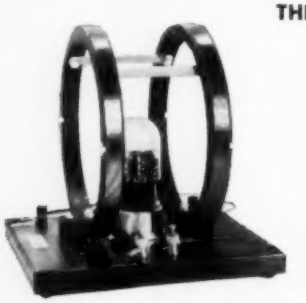
Stream of electrons being bent to circular path by magnetic field. CENCO e/m APPARATUS.

FROM CENCO®—

FOR ADVANCED PHYSICS STUDENTS

. . . intimate contact with subatomic phenomena

Fire the imagination and enthusiasm of advanced physics students with this instructive apparatus for measuring the e/m ratio. Using a new improved electron tube and accurately positioned Helmholtz coils, the experiment is based on the fact that an electron stream is bent into a circular path by a magnetic field applied perpendicularly to the path.



THE EXPERIMENT: The fundamental equation $e/m = \frac{2X10^8V}{H^2r^2}$ is the basis of the experiment. The "V" is read directly. Coil current is measured and from it, "H" is determined. The radius of the electron path may be read directly in ½ cm steps on the target within the electron tube.

Designed to give much longer life than previous models, the new electron tube used in the apparatus provides increased brilliance in a high actinic beam readily visible and easy to focus. The concentric rings, with radii of ½ to 2 cm, are fluorescent filled so that the point of impact of the beam is visible for positioning and accurate measurement.

Write for further information.

No. 71264 Cenco e/m Apparatus—complete with Electron Tube and operational directions **$195.00**

cenco

The most complete line of scientific instruments and laboratory supplies in the world

RS

CENTRAL SCIENTIFIC COMPANY

General Offices and Factory—1718-O Irving Park Road • Chicago 13, Illinois

Branches and Warehouses—Mountainside, N. J. • Boston • Birmingham
Central Scientific Co. of California—Santa Clara • Los Angeles
Refinery Supply Company—Tulsa • Houston
Central Scientific Co. of Canada, Ltd.—Toronto • Montreal • Vancouver • Ottawa